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June

Cassiers

ENGINEERING MONTHLY

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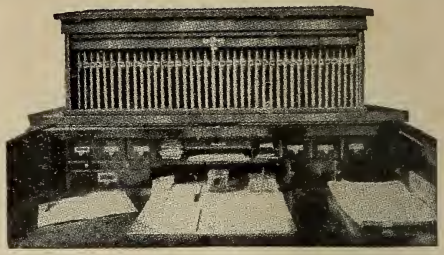

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CASSIER'S

ENGINEERING MONTHLY

ESTABLISHED 1891

HENRY HARRISON SUPLEE, EDITOR

CONTENTS FOR JUNE

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JUNE 1913

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July Cassier's

General Bixby, Chief Engineer of the U. S. Army, on

The Truth About the Floods Showing that not forest denudation, but modern development and the restriction of our water-courses are the real reasons for the enormous flood destruction. Other prominent engineers express their opinions on the subject of flood-prevention in this number.

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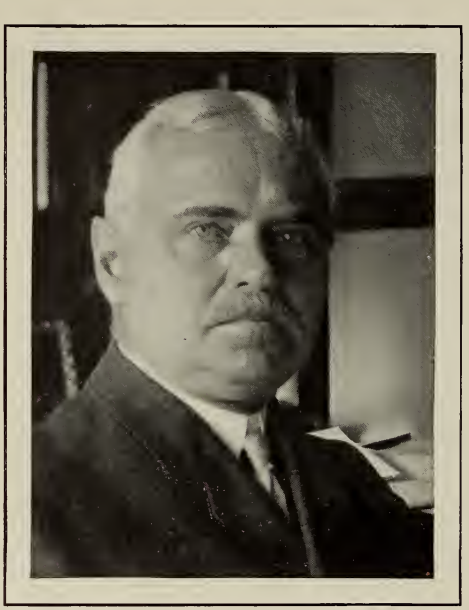


COL. GEORGE W. GOETHALS

It is his work upon the Panama Canal, in which he has shown remarkable capacity as an engineering executive, which has rendered Colonel Goethals notable throughout the civiiized world, and it is hoped that he may crown this work with its logical successor, the engineering works which shall control the rivers of the United States, and prevent the recurrence of disastrous floods.

CASSIER'S

ENGINEERING MONTHLY

VOL. XLIII JUNE, 1913 No. 6

Has 1–6. on microfilm

PREVENTING THE FLOODS

HOW MILLIONS OF DOLLARS USELESS WASTE CAN BE SAVED THROUGH THE UTILIZATION OF THE PANAMA CANAL EQUIPMENT

BY HENRY HARRISON SUPLEE

"After the Deluge!"—what? Are we in a thorough and scientific manner to take this Flood Problem in hand and solve it as it should be solved, and for all time; or are we to experiment with half-methods of protection and witness again in different sections of our country, year after year, such onrush of immense volumes of water as recently wrought death and destruction throughout the land

"AFTER us the Deluge!" Whether or not this historic exclamation was remembered by those who, knowingly or unknowingly, modified the conditions under which the rainfall formerly made its way to the streams of the Middle West, the fact was most abundantly demonstrated by the floods which, during the recent spring, wrought death and destruction in Pennsylvania, New York, Indiana, Ohio and other states. Deprived of most of the natural methods of retardation, and directed by the feeders of the great watercourses along the areas in which busy populations had developed some of the most important industries of the land, the force of immense volumes of moving water has been directed, not to the "use and convenience of man," but to his great injury and loss.

In the pages of this magazine for the issue of August, 1912, attention was directed to the inadequacy of such palliative methods of controlling the flood waters of American rivers as are included in the construction and maintenance of levees and bank protection in the lower reaches of the streams, and at that time the importance of adopting controlling and preventive measures at the head waters, and along the extent of streams, was emphasized. This discussion was included under the general editorial caption of "Looking Forward" and, since it was published, nearly a year ago,

it will be seen that the warning conveyed therein was amply justified by the events of March, 1913.

Any doubt as to the amount of energy contained in moving water will be removed by an examination of the havoc wrought by the floods of the spring of 1913, but any attempt to regard such a disaster as an act of Providence, against which man is incapable of making adequate defense, is wholly unjustifiable.

Like every other natural force, moving water is a bad master but a most valuable and efficient servant, and there is no reason why it should be permitted to gain the mastery over human control. When masses and velocities are allowed to become too great, it also has become too late to regain the control over them which might have been maintained under wiser provisions.

It has already been realized in other departments of activity that prevention of ill effects is far more effective and important than remedial measures taken after the harm has been done or is impending, and this is especially true in connection with the subject of flood waters.

In Nature there is a moderate amount of such prevention operating in connection with the influence of forests to retain and retard the run-off from rains, thus lengthening the time during which the gathering of the waters takes place, and somewhat reducing the violence and suddenness of the accumulation. The necessary clearing of the surface from forests, incident to the opening of the territory for cultivation, has removed so much of the timber that this effect has been materially diminished, and can no longer be depended upon to aid in regulating the run-off; hence, some definite artificial system must be installed to do this work, even more effectively than the forests could ever have done.

As pointed out editorially in this magazine in August last, the preventive principle for the control, not only of the Mississippi, but of other great rivers, lies in the construction of suitable storage reservoirs, not at the points where immense masses of flood water have been gathered from over great watershed areas, but at places much further up along such watercourses, and at such frequent intervals that at no point would any very high dam be necessary. By careful selection of suitable places, determined after accurate topographical surveys, there would be found points where suitable reservoirs could be formed simply by diverting the excess water into lower lying areas, in such a manner that large volumes of water could be held in reserve, at the time of heavy rainfall, and not permitted to get down to the dangerous districts at all until released at a later season. Such storage reservoirs may be situated at points where there is no danger to populated districts, and need not involve the construction of high or dangerous dams, as in cases where very high heads of water are concerned.

With the knowledge which exists as to the climatology and topography of the watersheds of the great rivers, together with the further information which may readily be derived upon allied details, it should be possible so to meet the rain-

"IT is not a consideration of how much it will cost to do it; but rather how much it will cost *not* to do it."

"ANY attempt to regard such a disaster as an act of Providence, against which man is incapable of making adequate defense, is wholly unjustifiable."

fall of the various seasons as to render it of minor importance to go to any especial precautions to protect the river banks of the lower reaches of the streams, and make it practicable to do for American rivers what the Assouan dam and reservoir has done for the Nile, or the Gatun dam and lake for the control of the Chagres. Instead, however, of concentrating all the storage and regulating capacity at a single point, with all the responsibility which is involved, the true method, taking especially into account the length of the rivers and the areas drained by them, indicates the construction of a number of storage reservoirs, of large area, but moderate head, avoiding danger and distributing responsibility, besides furnishing far greater flexibility of regulation.

PHOTO BY UNDERWOOD

View at Watervliet, New York, on the Hudson River, showing the manner in which buildings were torn from their foundations and carried away by the flood. The total flood losses this year are estimated at one hundred million dollars.

The popular idea of dams and storage reservoirs includes the conception of massive walls of earth or masonry, and immense masses of water, held back, ready to rush down upon the people and places below if at any time the control should fail. This conception may be true in the cases of certain great irrigation or power reservoirs, but when the prime question lies in the regulation and control of the flow, the conditions may be made very different.

In many stream-valleys in the mountains of the West there may be seen, carried high up along the mountain side, flumes bringing the water from the higher sources of the streams along at upper levels, and enabling it to be supplied at a high pressure to some point much farther down the valley, to which gravity has already carried the general flow of the stream. If such a flume be followed up until the point of departure from the main stream is reached, there will usually be found, not a massive dam of masonry, holding back a great head of water, but rather a slight diversion weir, acting simply to direct the current toward the bank from which the flume is led. It will thus be seen that the construction of restraining reservoirs need not involve the building of high and costly dams, nor the creation of fresh sources of danger in the form of great masses of water under such heads and pressures as might become unmanageable. In this respect much depends upon a judicious selection of sites, and a careful study of the topography of the upper watersheds is necessary.

It is probable that most of the material, in the form of surveys, is already available. Such a study of land levels would doubtless permit sites to be selected which would enable large areas of moderate value to be overflowed by a slight rise in flood levels, and the volume of water thus diverted would afford a corresponding relief to the more densely populated districts, hundreds of miles farther down the stream.

PHOTO BY UNDERWOOD

The submerged freight yards of the Pennsylvania Railroad at Youngstown, Ohio.

PHOTO BY UNDERWOOD

The damages done to this railroad system alone exceeded four million dollars

It is evident that the proper control would better be effected by a large number of reservoirs, or artificial lakes, than by fewer sites of greater depth. The sudden rise of a stream, which in most instances creates the destructive flood, is formed by an aggregate discharge of a number of feeders, and thus a series of lakes, situated, not on the main rivers, but rather upon the principal supplying streams, would hold the water in far better control and with much less risk than any other plan.

The time element is a matter of vast importance in this connection, and it is quite possible for a stream to relieve a large watershed effectively and safely if the emergency flow can be distributed over only a slightly longer period of time than would be necessary for its unrestricted discharge.

It is the cumulative effect of successive tributaries which sweeps along the lower reaches of the great rivers, which creates damage exceeding in a single season the cost of proper controlling works.

One of the objections which has been advanced against the creation of storage reservoirs has been that of the great cost of the land required. It should be remembered, however, that we have no choice as to the fact that lands are to be overflowed, and that the real question is whether these overflowed lands shall include prosperous cities, farms and industrial centres, or whether they shall be so selected as to work a minimum of loss, or a possible gain. The rains will continue to fall, and the rivers to be filled, and the water must be taken care of; but the forces thus developed should be directed to the use and convenience of man, and not to his misuse and inconvenience.

A study of the climatology of a watershed, together with the comparison of time periods of stream flow and of catchment areas, would enable a scientific system of control to be formulated for each district, while a complete telephone scheme for communication would enable rising waters to be retained and released in such order as to provide an almost uniform flow through the lower-lying districts which would be otherwise overflowed and injured. A river should be treated as a whole and not in isolated portions, and the importance of this will be perceived as soon as it is realized that each portion is governed, not by the control works of its own vicinity, but by those above it.

> **"IT is not a matter of choice, it is a question of national defense against an internal enemy."**

> **"THE men and weapons who have been victorious at Panama are available to be directed, under the same experienced leadership, against this powerful opponent, removing forever the menace which is today the most formidable enemy of the United States."**

The fact cannot be too strongly emphasized that the volume of water controlled does not depend upon the construction of immense dams. The dikes of Holland are of moderate height, and yet serve to protect the coast against all the waters of the North Sea. The real engineering problems involved in the American rivers are those included in the selection of sites, in the scheme of continual

supervision and control, and in the harmonious co-ordination of all the elements of which the problem is composed.

It is evident that such a result can be accomplished only by a centralized and authoritative organization, with all the powers which can be derived from National sources. It is an Interstate question, and one which can be met only by higher and more unified control than is possible by any system of local work.

Engineering works in one State may render little or no service to the State in which they are situated, and the protection which they exert must frequently be given wholly to areas and cities hundreds of miles away, in other communities, having other interests. Manifestly it is impracticable to expect such works to be constructed at the expense and under the direction of the State which can expect no return itself directly from the investment. The scheme must stand as a whole, governed, not by political and artificial boundaries, but by such natural elements as the elevation and contour of the surface, by the direction of water courses and the nature of watersheds, and by the local character of rainfall and run-off.

It is true that in most instances such controlling works would also include the utilization of the water power thus developed, and it is one of the valuable elements of the scheme that the tremendous energy which is ordinarily expended in destructive action would be modified and regulated to become available for the use and convenience of man. To this extent there would doubtless be a local benefit derived from the regulating works, and to the development of power might be added the distribution of water for purposes of irrigation.

Viewed as a whole, the problem consists in the creation of a system for averaging and equalizing one of the most irregular and unequal of natural forces, the power of the waters which fall upon the earth. It is interesting to note that such an equalizing action now exists in the case of the glaciers of the Alps; the fall from the sky, in the form of snow, being largely stored in the glaciers, and slowly melted to supply the streams, which supply the rivers.

When it is realized that the yearly averages of rainfall are fairly uniform for definite localities, over long periods of time, it is evident that some sort of fly-wheel action is essential for the conversion of the irregularities into a fair approximation to that average. In past generations this equalization was partially effected by the existence of large wooded areas upon the watersheds, retarding and absorbing the rainfall to such an extent that the time element was introduced in a manner now absent. It has been said that even such an inconspicuous detail as the existence of numerous beaver dams upon the small feeder streams created many retarding pools which converted turbulent mountain streams into well-behaved currents.

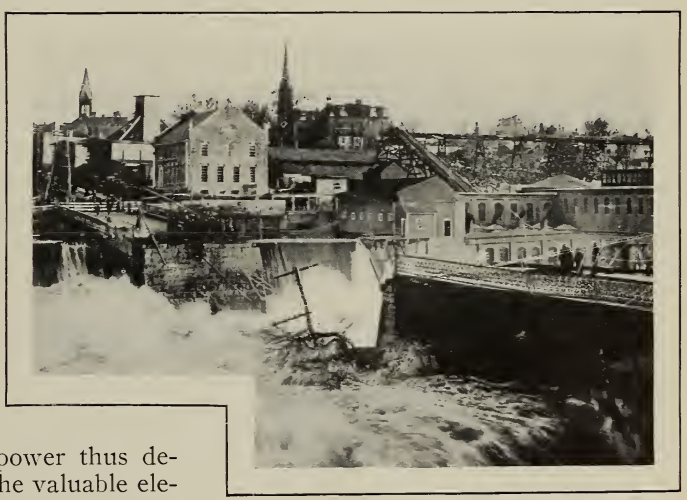


PHOTO BY UNDERWOOD

At Glens Falls, New York, after the Steel Bridge had been washed away. The rush of an uncontrolled mass of water which might have been made a useful servant under better conditions.

The great example of entire conversion of an extreme torrent into a con-

trolled channel appears in the solution of the problem of the Chagres river in connection with the construction of the Panama canal, by the creation of the Gatun Lake. The rains, which have been known to cause a rise of more than forty feet during a single night in the uncontrolled river, will cause a difference of level of but a few inches in the 150 square miles area of Gatun Lake. This is an extreme case for an extreme purpose, but it includes the lesser cases within its limits. Just as the wide variations in the duration of human lifetimes are equalized and averaged in the creation of the averaging reservoir of life-insurance systems, so the irregularities of rainfall and flood waters may be converted into uniformity, safety and profit, instead of variability, danger and loss. This result can be accomplished, however, only by the exercise of highly concentrated and centralized authority and power. It is a problem which can be executed successfully only by the general National Government, after a well-considered, scientific, National plan has been prepared. The work of the Coast and Geodetic survey is an example of the National character of such an undertaking, while the engineering features are more akin to those which have been so successfully handled at the Isthmus.

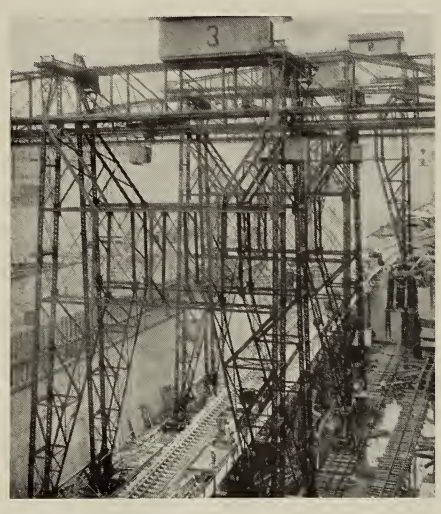


PHOTO BY UNDERWOOD

Some of the Great Steel Cantilever Cranes in use at Panama, and available for service in the construction of controlling reservoirs to improve the rivers of the United States after the work on the Canal Zone is completed. Nearly all the Panama equipment could well be transferred to the upper river districts of the Mississippi for improvement works, instead of being sold on the second-hand market.

One of the most important elements in the conduct of such a large undertaking as has here been outlined lies in the preparation of the original plans, and in the conduct of the preliminary work. This may well be realized when the work at the Isthmus is studied, and, while questions of sanitation would hardly become as prominent in the United States as they proved to be at Panama, there are other things which might well be taken up and considered in advance of any constructive work.

The great thing at the present time is to have some broad and definite plan prepared, after which the successive elements of which it must be composed may be formulated and initiated. The questions involved in the location of storage sites, and the acquirement of the control of the lands, must necessarily be taken up, and these might well form portions of the work of executive departments already capable of dealing with them.

By the time that the preliminary work has thus been done there will be released for the engineering and constructive portion of the undertaking a complete organization and equipment, unequalled, both in personnel and experience, by any in existence—that now completing the great undertaking at Panama. The manner in which the works at the Isthmus have been carried forward to completion by Col. Goethals and his men emphasizes in an incontrovertible manner the fact that it is to their hands that the scientific prevention of disastrous floods in the United States, and the conversion of its rivers from enemies into friends, should be entrusted. The men who have tamed the Chagres know already how to control the Mississippi, the Ohio, the Missouri and their feeders; they have the equipment, the experience and the organization.

It cannot be too strongly impressed upon the Government that it would be a colossal blunder to permit such an efficient and coherent body of men to be

PHOTO BY BROWN BROS.

Where the Flood Waters Come From.

Mountain streams, such as this, drain large watersheds, and become torrents when the spring rains and thaw deliver great volumes of water in a short period of time. It is at such points that controlling reservoirs would enable the water to be held from flooding the lower reaches of the rivers, and convert the flood into a useful source of power and irrigation.

dispersed at a time when such an important task is impending; nor should any portion of the mechanical equipment available for the coming task be disposed of while so much good work is awaiting its activity.

Panama was undertaken to create a new channel between the oceans, both for naval and mercantile progress. The desirability of this great work is undisputed, but there was no immediate menace to life and property if it had not been undertaken. If, however, the rush of flood waters every spring upon the great rivers of the United States is not controlled, there must continue each season such loss of life and money as we have experienced even now. It is not a matter of choice; it is a question of National defense against an internal enemy.

It is not a consideration of how much it will require to do it, but rather how much it will cost not to do it. At Panama the right of way had to be acquired, at the cost of millions; here the sovereign authority already exists. At Panama the causes of disease and death had to be investigated and an ignorant population compelled to accept sanitation; here both climate and population are already understood and regulated. The transport of men, machinery and materials was diffiicult at the Isthmus and is simple in the United States; the conduct of the work needs little or no variation from that which is already current at the very sites of operation, and the labor question is immensely simplified.

> **"PREVENTION of ill effects is far more effective and important than remedial measures taken after the harm has been done."**

It is doubtful if the exact magnitude of the losses caused by the floods of 1913 will ever be precisely determined, but already certain estimates have been made which are probably well within the limits of actual fact. The Public Utilities Commission of the State of Ohio places the property loss in that State alone at $350,000,000, and to this should be added the cost of the relief of half a million of destitute persons for a period of at least three weeks. The Ohio loss thus reaches almost the entire amount of the cost of the Panama canal, without taking into consideration the losses occurring in Indiana and elsewhere. It is estimated that the average loss due to floods in Ohio alone reaches about $50,000,000 yearly, a tax which in itself would go far toward the installation of the necessary controlling works.

Apart from the necessity of so controlling the flow of streams in such an effective manner as to prevent disastrous floods, this principal element is accompanied by several secondary features, themselves capable of valuable development. The forces, which, during uncontrolled flood seasons, work so much injury, may when properly regulated, become valuable sources of power, and if, as seems probable, the demand for electrical energy in connection with the transformation of agricultural operations into mechanically operated undertakings appears, an ample market for such power would be developed within practical reach. The question of the revival of river navigation is less promising, but it offers possibilities which should not be overlooked in the general plans for river control. Irrigation problems are necessarily combined with any discussion of the storage of water, and, in most instances, these minor elements might well be considered in a manner similar to that of by-products.

Evidently the thing to be done at the present time is to obtain an expression of opinion from the eminent engineers of the United States, both as to the feasibility of the scientific control of the flood

waters of American rivers by the storage system, and as to the importance of retaining the equipment and personnel of the Panama Canal work to carry out such an undertaking.

Surely, if the United States government can acquire control of a zone of foreign territory, and expend upon it hundreds of millions of dollars to construct a waterway, primarily for naval purposes and also to provide for the commerce of the world, it can utilize the experience and equipment resulting from the development of that undertaking, for the purpose of preventing yearly losses of millions, of saving hundreds of lives, and of conserving great natural resources, within its own territory.

When the magnitude of the undertaking is realized, and the direct and immense economic value of its achievement is made public, it seems clear that immediate action is necessary.

> "IF the rush of flood waters every spring upon the great rivers of the United States is not controlled, there must continue each season such loss of life and money as we have experienced even now."

> "IT is one of the valuable elements of the scheme that the tremendous energy which is ordinarily expended in destructive action, would be modified and regulated to become available for the use and convenience of man."

Millions of dollars are appropriated and expended every year upon an army and a navy to provide for the National defense against possible enemies, enemies who are now peaceful friends, and against whom it is most sincerely hoped that no armed defense will ever need to be exerted. Here we have, already existing, within our own borders, an enemy which can be depended upon positively to make a yearly attack upon defenseless citizens, destroying their property, interrupting their business, impeding traffic, stopping the mails and causing loss of life. If a foreign enemy worked a fraction of such damage, the whole nation would be up in arms, unlimited funds would be immediately forthcoming to fight the invader, and the victory over the enemy would be considered cause for great rejoicing.

There has recently been considerable agitation in the United States over the question of the right of aliens to acquire title to land in this country, and both State and National governments have been drawn into this important question. Important though it has been, this matter is trifling compared with the fact that, willingly or unwillingly, an enemy has already gained a hold upon great areas of the United States, working destruction to an extent far exceeding that to be apprehended from the objectionable colonies of Asiatics. The existence of an antagonist, already firmly entrenched within the very heart of the country, is a matter which must be recognized, and the sooner this fact is appreciated the more effective the line of defense can be formulated.

It has been said that a nation's first line of defense is the enemy's coast, but when the enemy is one of the forces of Nature, situated, not upon a distant coast, but above, within and around the great centres of industry, commerce and residence, the whole method of handling the question must be met upon different lines.

Fortunately, such a battle has already been fought and won, and the men and weapons who have been victorious at

Panama are available to be directed, under the same experienced leadership, against this powerful opponent, and need only the word to advance and subdue it, converting it into a tractable and valuable servant, and removing forever the menace which is today the most formidable enemy of the United States.

CASSIER'S FIRST TO BRING THIS GREAT ISSUE BEFORE THE NATION

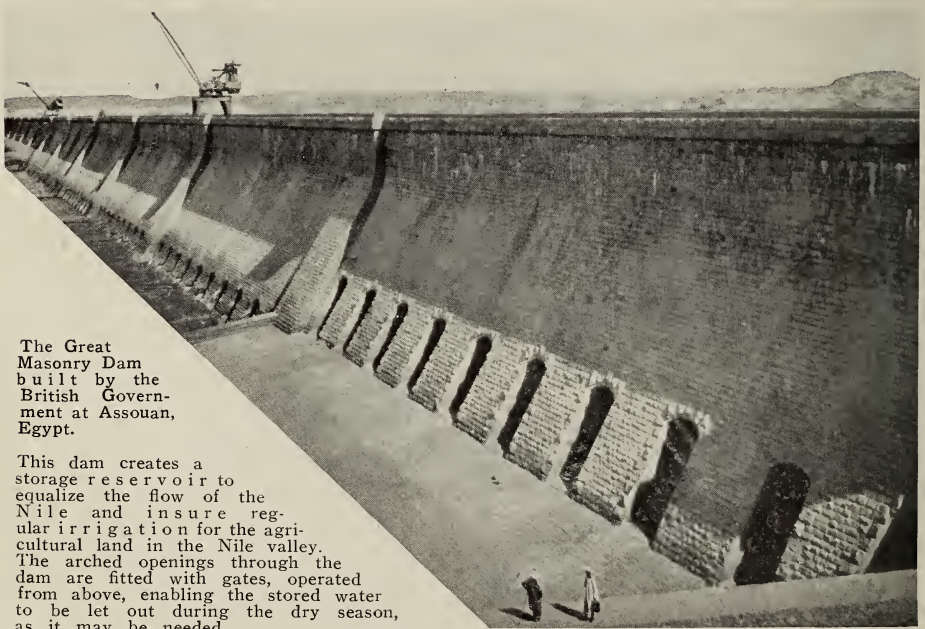
From Cassier's Magazine, August, 1912

WHEN the actual construction of the Panama Canal was studied by engineers of experience in the special departments of work involved, it became evident to all that the chief problem to be solved was not the cutting of a channel through the narrow portion of land forming the Isthmus, but rather the control of the irregular and torrential flow of the Chagres River. The fact that practically all the drainage of an extensive and steep watershed had to reach the sea through this stream, together with the climatic conditions which included much rainfall, rendered this portion of the problem a matter for serious consideration, since upon its practical solution depended the success of all the rest of the undertaking.

It is now well known that the creation of Gatun Lake, providing an extensive reservoir, into which the sudden increase of the volume of flow could be received without making any serious variation in level, was the true method of controlling the Chagres River and of converting it not only into a well regulated supply of water for the canal, but also of providing ample hydraulic power for all operative purposes.

Now that the work is nearly completed, it may well be considered if the lesson thus learned may not be applied, without delay, to the solution of a similar problem within the borders of the United States, and possibly save for the country losses which exceed the cost of the construction of the entire waterway at the Isthmus.

The destructive floods of the Missis-



The Great Masonry Dam built by the British Government at Assouan, Egypt.

This dam creates a storage reservoir to equalize the flow of the Nile and insure regular irrigation for the agricultural land in the Nile valley. The arched openings through the dam are fitted with gates, operated from above, enabling the stored water to be let out during the dry season, as it may be needed.

sippi River are of frequent occurrence, and it seems as if the existing methods of protection against them by the construction and maintenance of levees and bank reinforcements are inadequate, and even antiquated, when considered as sole defenses against the river floods. The lesson at Panama would indicate that the true method of treating the problem of the Mississippi would be the creation of a number of artificial lakes similar to that at Gatun, and for a similar purpose, their location and size to be determined by topographical and commercial considerations. A number of such lakes, produced by damming the stream at points where the accumulation of water could be controlled, would enable the excess of water to be stored and held back over such areas as would produce but moderate changes in level, even during the season of maximum flow, and thus protect the lower reaches of the river from danger and render the existing levees ample to insure safety. The stored water, as at Panama, would be available for regulated power development, and also enable the desired flow to be maintained during the season when low water would otherwise prevail.

The importance of considering this matter at the present time appears because the United States Government is now in possession of a complete organization, administration, and engineering equipment for the execution of such a plan. Instead of disposing of the extensive equipment so soon to finish its work at the Isthmus, the rational and efficient thing to be done would be its transfer to the Mississippi Valley and its immediate use in the creation of a series of regulating lakes which would remove permanently all further danger of flood damage while conserving the power of the great river for useful service. The most inefficient thing which could be done would be the disposal of the Panama equipment and the dispersal of its personnel while such an evident an immediate task is awaiting its services.

PHOTO BY BROWN BROS.

A Controlled Water Supply

How the water from mountain sides may be diverted from flooding the cultivated valley, and directed for use as needed. A western irrigation canal created from an uncontrolled mountain stream.

OPINIONS OF PROMINENT ENGINEERS

We have received many letters from engineers of national prominence expressing their views regarding this subject, and publish the following.

Others will appear in our July number including a most important and interesting statement regarding flood conditions, written by General W. H. Bixby, Chief Engineer of the U. S. Army.

From Clarence P. Cressey, East Orange, N. J.

"I am heartily in favor of such action, provided the various states will aid by taking the necessary measures to prevent destruction of forests and foster the growth of new timber where such measures are necessary.

"I believe the matter should be called to the President's attention by the Engineering Societies, and that it should be left to his discretion as to whether it is necessary to call a National Flood Congress.

"I would also suggest that this matter be taken up with the Governors of the various States when they meet in convention, as has been the custom for the last few years."

From Rudolph Hering, New York.

"There is no question of the enormous losses suffered by floods and of the necessity for correcting the causes.

"In order to do the latter a very carefully and well considered plan of operation must first be available, so as to have the vast equipment and organization soon to be disbanded at Panama to be employed.

"The U. S. Government Engineers have, I believe, the flood question in hand; at least they have the navigable rivers. I have seen some articles of Government engineers on the subject. I have also studied the river regulations on the Continent of Europe I believe as much as any American engineer. Unfortunately I do not think that these questions are attacked in our country in an equally efficient manner as they are attacked in Europe. From some articles I fear that some prevailing ideas will not give us the success expected.

"What I believe should be done first is to have a Commission appointed by Congress, of engineers, of this country as well as Europe, to discuss the whole question of river regulation in our country, and to formulate plans therefor which will prepare for the future, and reduce the future floods to a minimum, and also to regulate the rivers in such a way that flood damages will be obviated or minimized.

"The work to be done by such a Commission is very large, because it should comprise every watershed of the country, and settle the principles upon which the rivers should be adjusted in alignment, in section and in gradient, as done in Europe. When any section is improved it should be improved according to the established plan, so that eventually all will form a harmonious whole."

From R. H. Fernald, University of Pennsylvania.

"The project impresses me as a very timely and important one, and I believe that if definite action can be pushed speedily enough through a National Flood Congress, the suggestion made that the President call together such a Congress for consideration of the matter is a desirable one."

From Philetus W. Gates, of the Hanna Engineering Works, Chicago.

"I thoroughly endorse the plan which you suggest and believe there should be no trouble in bringing this about especially as this method has been advocated by the Government itself for many years, and I think there has been a large amount of work done in making surveys, etc.

"I would respectfully suggest that such work as is done by the engineers in furthering this plan be in conjunction with that department of the Government which has had this work in hand, as the more influence which can be combined, and especially if it is in accordance with the work of some department of the Government, the more likely results will obtain."

From Alfred Brooks Fry, Chief Engineer of United States Public Buildings, formerly member of the Board of Consulting Engineers of the New York State Canals.

"I strongly endorse your expressed views. Some knowledge of the Missouri Valley, of the Mississippi and its tributaries, and considerable study of regulated rivers in Europe, and the Nile, have led me to believe that the practice followed for years in the Mississippi Valley, of depending almost wholly upon levees, is erroneous, and that a further study should be made, by a competent body, of this entire question, to see what regulation by water storage is possible or practicable.

"I grant the physical difficulties; but some of them are no greater than have been overcome on the Nile, on the Po, or on the Danube; and I grant the enormous expense involved; but if we are to have a repetition of the damage by flood that has afflicted the Mississippi and its tributaries from time to time, notably during the past five years, almost any expenditure that it is within the power of rich states and a great nation to undertake would seem justified."

From F. W. Dean, Boston.

"It strikes me that this would be a good idea. I do not believe that it would be best to favor calling by the President of a National Flood Congress. It seems to me that if the matter were brought before the President he might have the War Department make a study and estimate of the cost of beginning this work, and have a bill put through Congress to have the work begun by the War Department."

THE NEW INDUSTRY
AND THE OLD INEFFICIENCY

What department of activity comprises 40% of the total wealth of the United States?

What industry has to feed not only its own dependents, but also those of the other 60%?

Do you know the plans which are being made to double the new wealth now being produced each year by this department of industry?

Do you know how this will affect you?

THE NEW ERA IN FOOD PRODUCTION. The total wealth of the United States is estimated by the Bureau of the Census at a little more than one hundred thousand million dollars. About eighty per cent of this wealth is included among three great departments of industry: AGRICULTURE, MANUFACTURES and RAILROADS, in the proportion of about forty per cent in agriculture and twenty per cent for each of the other two, the remaining twenty per cent being of a miscellaneous character. The product of the forty per cent of the wealth invested in agriculture has to feed not only its own share of the population and the animals which it employs, but also the other sixty per cent. Notwithstanding this disproportionate burden, the art of getting subsistence out of the ground, the biggest industry in the world, has been dependent almost wholly hitherto upon human and animal energy for its motive power.

The application of Scientific and Engineering Methods to the Soil. A series of Articles Dealing with the Coming of the New Era in Food Production, and of the Scientific Exploitation of the Earth.

An interesting feature of forthcoming issues of CASSIER'S.

The Agriculturists of this country, even the modern so-called intensive farmers, have not progressed as rapidly in methods of

performing work as has been the case in nearly all other lines of industry, and yet it is on the agriculturist that all the people of the world depend for their life and strength to perform any kind of work.

Now, however, there has arisen a NEW INDUSTRY, the application of manufactured power to the cultivation of the ground, and the application of scientific methods to the maintenance of its fertility. During the year 1912, the actual value of the crops taken out of the soil of the United States amounted to more than nine thousand million dollars of new wealth. If to this we add the value of animals raised for market during the year, the amount of new wealth thus produced reached nearly ten thousand million dollars in value.

Practically all of this wealth was produced under the OLD INDUSTRY of Agriculture. If the same area had been worked according to modern scientific methods, with modern power machinery, a value of more than double this enormous amount would have been produced, and with far less effort and expense. It is the NEW INDUSTRY of Scientific Agriculture which is thus to meet the demand for subsistence and check the advance in cost; it is the NEW INDUSTRY of the application of aggregated capital and power machinery to the cultivation of the ground which will create greater industrial values than those produced by all the manufacturing industries and all the railroads of the world.

An acre of land in the United States today produces only about fifteen bushels of wheat. Properly cultivated by power machinery, it may be made to yield forty bushels. When the ground is worked as the iron beds of Minnesota are being worked, not by men and horses, but by power tractors and railways, the NEW INDUSTRY of power farming will double its efficiency.

The questions of improved agricultural methods, the replacement of physical strength by power machinery, the efficient operation of agricultural enterprises and the marketing of the products are ones on which the future health and happiness of the people of the world largely depend, and are treated in full in this series of articles in "CASSIER'S."

THE NEW INDUSTRY

THE REPLACEMENT OF MEN AND ANIMALS BY POWER AND MACHINERY MODERN AGRICULTURAL METHODS WILL PREVENT THE WASTE OF ONE FIFTH OF OUR FOOD

BY L. W. ELLIS

A Motor Driven Ensilage Cutter

THE old idea of a little farm, well tilled by its resident owner, is a pleasing inheritance from the past. It formed an agreeable picture, but we must not blind our eyes to the fact that it is wholly inadequate to present-day conditions, or to the knowledge that a great change is taking place.

The entire history of American agriculture may be divided into periods based upon the development of farm machinery; and, in brief, into three fairly distinct periods.

The first period covers the era of hand methods, continuing well toward the middle of the nineteenth century. In fact, until about 1850, the wagon, the cart and the cotton gin were practically the only implements or machines which did not belong to hand methods of production.

The second period includes the era of transition from hand to machine methods, and may be placed from 1850 to 1870. At the latter date nearly all of the modern agricultural machines were in the field in some crude form, and the idea of superseding hand methods by machinery had firmly fixed itself in the mind of the average farmer.

The third period, which followed from 1870 to the close of the century, marks a rapid improvement, and may be called the era of farm machinery. During this era, scientific breeding, based on the introduction of improved foreign stock, improved the efficiency of the average farm horse at least 25 per cent. During the same time the number of horses and other work animals used on farms for each farm laborer also increased about four-fold. The influence of even this change in the introduction of power, although still animal power, is seen in the greater efficiency, the production per farm laborer being increased about five times.

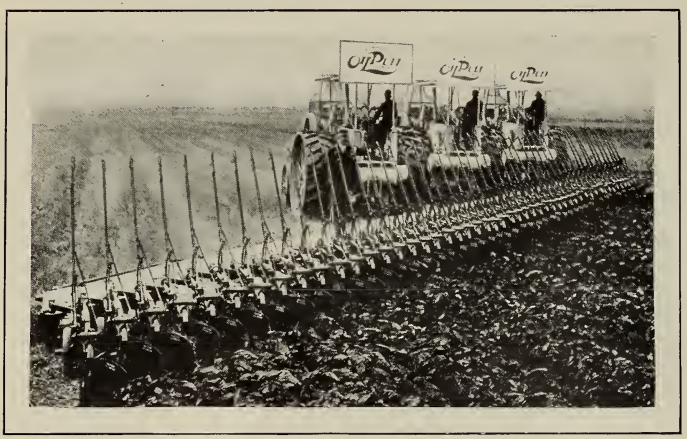
The result of these developments in the introduction of mechanical appliances, especially in increasing the amount of animal power, soon became apparent.

The farmer found both his own efficiency and that of his men improved, both being relieved of much drudgery and enabled to live more comfortably and intelligently.

The introduction of machinery on the farm was found to decrease the cost of production and increase the proportion of profit. It was also found to reduce the proportion of laborers required to produce the food supply of the nation, thus freeing men for industrial development along other lines. In 1800 there

> *"It is estimated that there are in the United States, fifteen million work horses now employed, and that at least ten million more are required to meet present demands. The food for these animals alone costs more than a billion dollars each year, equaling the total income of two million average families."*

were required four families on the farm to support one family in the town. To-day two families in the country support three families in the city, and still leave a balance for export. Under such a stimulus the cities have felt the neces-



These three oil tractors are pulling fifty bottom plows, covering an acre in four and a half minutes. How long would it take three horses to accomplish the same amount of work?

sity of providing work for the increased army of workers, and this again reacts upon the farmer, rendering it necessary for him to produce a continually increasing surplus of food beyond the needs of his own family.

Doubtless one of the reasons why the application of manufactured power to the soil has been so long delayed lies in the difficult conditions which must be met. The material cannot be brought to a central factory, but the power plant must be capable of going from place to place and doing its work wherever found. This involves the limitations of topography, climate and soil, and renders the mechanical problem of designing an efficient farm tractor much more difficult than that of making a stationary engine. Another reason is found in the conservative attitude of the farmer, who is much slower to adopt changes than the manufacturer, in the whirl of modern competition. It is now conceded, however, that the farmer must adopt mechanical power on a scale comparable with the other two great industries, if he is to meet the continually increasing demand for food. Yet another reason for the delay in the introduction of mechanical power in agriculture appears in the irregular demands of the service. For a considerable portion of the year the amount of power required is moderate, while during the active season a high peak load is reached. This applies as well to animal power as to manufactured power, and one of the great burdens upon the farmer imposed by animal power is found in the necessity of feeding and caring for horses during the winter season.

The peak load in agriculture occurs in plowing, and it is estimated that even on old land 60 per cent. of the power consumed is expended in plowing, although this is only the shallow plowing now prevalent. If the maximum yield is to be obtained from the ground, much deeper plowing should be used, and this means the requirement for still more power during the brief plowing season.

That this demand can be met by the continued use of animal power is out of the question. The slow processes of animal reproduction cannot yield the surplus power quickly enough, even if it were desirable to continue the use of animal power. It is estimated that there are in the United States fifteen million work horses now employed, and that at least ten million more are required to meet present demands. The food for these animals alone costs more than a billion dollars each year, equaling the total income of two million average families. The crops from one-fifth of the cultivated acreage are withheld from supplying human needs in order to supply animal

What per cent of the food produced by these animals do they consume?

power for farming, and any increase in the proportion of animal power would increase this consumption still further.

If, however, we turn to mechanical power, we release the production of from five to twenty-eight acres for every horse displaced by machinery and employ a source of power which consumes nothing which could be converted into food for mankind.

If we consider the influence which the application of manufactured power has had upon manufacturing and transport, we may gather some idea of what may be expected from similar developments in agriculture. The pack mule and the prairie schooner have given way to vast railway systems, and the caravel to the great modern ocean steamships. It costs less to send a bushel of wheat from New York to Liverpool than to haul it with teams from the farm to the railway station. The cost of transporting farm products by team averages about 23 cents per ton-mile, while the railways of the United States haul freight at prices as low as three-eighths of a cent per ton-mile. The cost of fabrics, illumination, warmth and utensils has been lowered by power manufacturing to a point which has rendered individual production utterly impracticable. The drift of labor has been away from the farm to the factory, and yet it is in the factory that manufactured power is used with all the manual labor employed, while the farm, thus depleted, is only beginning to apply power to do its work.

The development of the power-driven factory brought about certain changes in the conduct of manufacturing operations, and it is to be expected that similar changes will follow the application of manufactured power to agriculture. These changes will include both scope and management. Mechanical power can be efficiently applied to much better effect upon the large farm than to the smaller area, and with the development of the large, power-worked farm must come correspondingly broader management. The fact that many large farming ventures

What a waste of power and time! Old and inefficient method of harvesting grain.

have failed, or have been reduced in size, is due to the lack of men of large calibre leadership. When old David Rankin, proprietor of 25,000 acres in Missouri, died recently, he was regarded as a captain of industry. Yet keen, quiet, college-trained boys are now taking hold of enormous farm enterprises and handling them quite successfully.

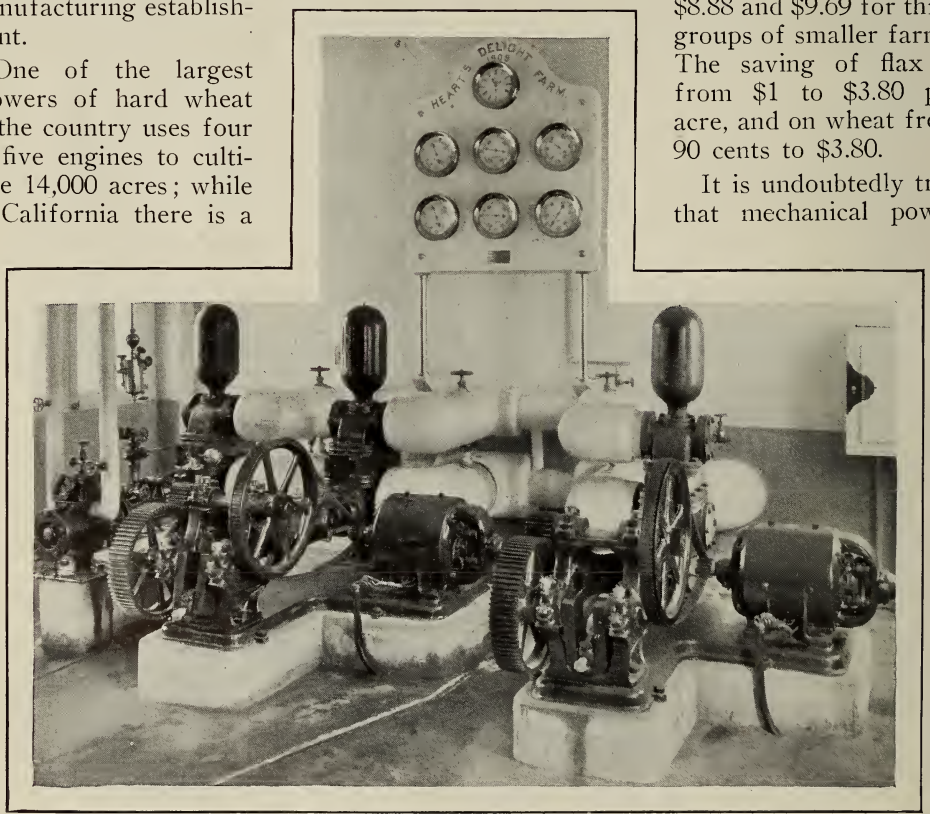
There is a syndicate in Kansas operating a ranch of 25,000 acres in a manner which might serve as a model for the entire country. It is cutivating 8,000 acres of corn, 2,000 acres of alfalfa, besides miscellaneous crops, together with 11,000 hogs and 6,000 cattle, and has been under the charge of its present manager for fifteen years. Here the brunt of the heavy work is borne by two big traction engines, while the system of accounting is as complete as that of any great manufacturing establishment.

One of the largest growers of hard wheat in the country uses four or five engines to cultivate 14,000 acres; while in California there is a ranch of 16,000 acres, of which 10,000 acres are devoted to sugar beets. At the time of the writer's visit, about two and a half years ago, this plant was using ten traction engines, each actually replacing sixty horses.

Large units are undoubtedly the most economical in agriculture, as in other industries. A certain farm of 1,800 acres in Minnesota, on which accurate statistical investigations have been conducted, pays higher wages than twenty-five small ones on which similar records have been kept. While the rates of depreciation on the farm machines are, in the main, higher, yet the machine cost per acre of crop handled is less, because the machines are worked more nearly to their capacity.

Thus the cost of producing an acre of barley on the large farm was $6.18, as against $7, $8.88 and $9.69 for three groups of smaller farms. The saving of flax is from $1 to $3.80 per acre, and on wheat from 90 cents to $3.80.

It is undoubtedly true that mechanical power



Motors used in the manufacture of ice. They are operating the Brine Circulation Pumps.

This apparatus, used for milking cows, is operated by a motor-driven vacuum pump.

encourages the existence of large farms, and that the size of the farm must depend, to a certain extent, upon local conditions. In the older portions of the country, where the land had to be cleared of trees before it could be brought under cultivation, the size of the farm depended largely upon the destructive ability of the settler. The sizes of farms thus determined have persisted to a large degree, down to the present time. On the Western prairies, however, the size was governed more generally by the amount of power which could be applied, and under the earlier conditions this meant the number of horses which could be handled by one man.

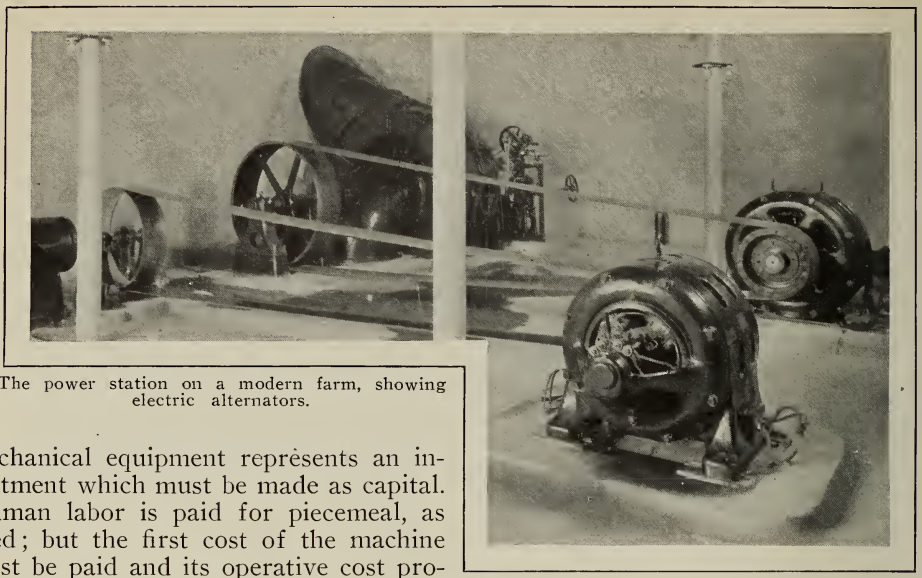
In general, it was found that the maximum manageable team consisted of four horses, and hence the Western farms are generally multiples of the area which can be handled by such an outfit. In the Southern States the unit is the mule, and large farms in that section are really groups of plots, each farmed by one negro and one mule; hence such expressions as "a ten-mule farm," etc.

With the introduction of the power tractor this capacity of the machine may become the unit of farm capacity, and the "thirty-horse tractor farm" or the "sixty-horse tractor farm" may become current parlance, while the delivery of electric power to farms within transmission distance of great power stations may develop other units.

Assuming, then, that successful farming of the immediate future must be done largely by power machinery, it may be desirable to examine some of the modifications which will probably follow.

> **"IN 1800 there were required four families on the farm to support one family in the town. Today two families in the country support three families in the city, and still leave a balance for export."**

It is probable that the introduction of mechanical power on the farm will save wages rather than money. Nearly every mechanical equipment to replace human labor has involved the investment of a greater amount of capital than before, but has brought with it a vastly increased output, and this will naturally continue to be the case. The



The power station on a modern farm, showing electric alternators.

mechanical equipment represents an investment which must be made as capital. Human labor is paid for piecemeal, as used; but the first cost of the machine must be paid and its operative cost provided for.

With the machine the interest on the investment is substituted for the wages of the men it replaces. The man who has only his labor as his capital is coming to the same point on the farm as he has come elsewhere; he cannot compete with machines, which represent money and provide a lower cost of production. It is to be expected that the entrance of large-capacity, power-driven machinery on the farm will meet with opposition similar to that which was met in manufacturing operations, but the extent to which the application of power will create new opportunities for labor will provide for many more men than those displaced by machinery.

The modern world is being shaped by power; and, broadly, this action may be divided into three great departments; the production of raw material, as in mining and agriculture; the transformation of the raw material into forms adapted for service, as in manufacturing, and the transport of both raw material and manufactured products to the points where they may be used.

The development of these three departments has not been symmetrical, and the applications of power to manufacturing and to transportation have been far more highly advanced than has thus far been the case in the production of raw material, especially in agriculture. The factories have centered production and transferred the processes from the homes to the mills, taking with them much of the best blood and capital. Transportation has aided in this process, but both are now acting to equalize the situation by sending back to the country both machines and engines to replace the men which they have absorbed.

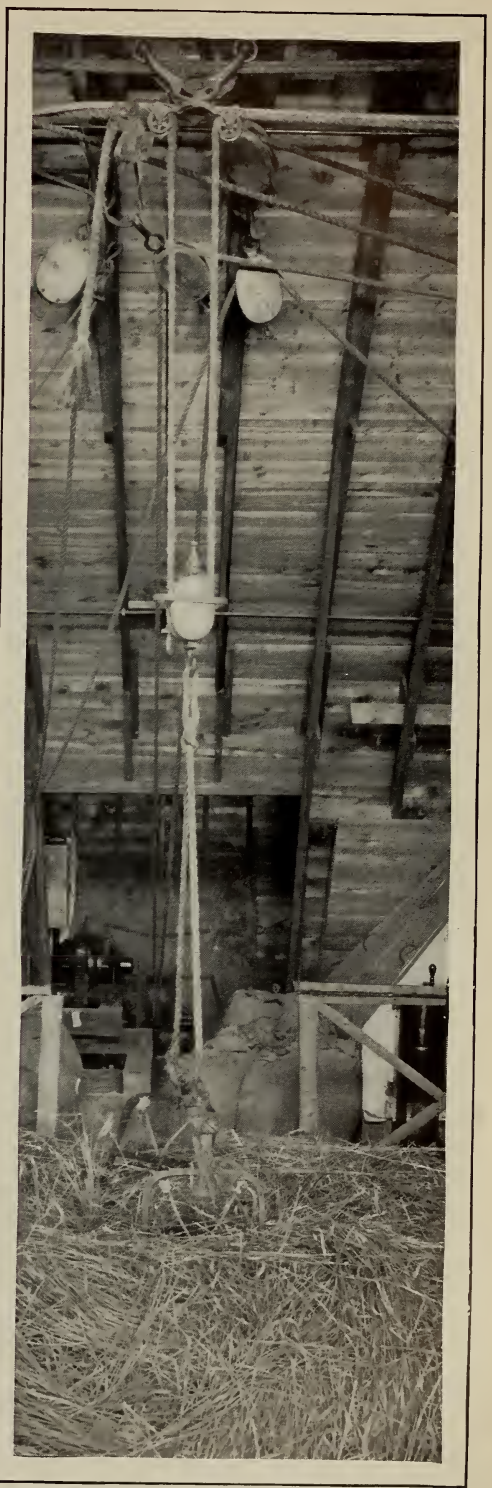
The great power-driven factories are producing all kinds of things at enormously cheaper rates and much more efficiently than was possible in the old days of household industries, while the application of steam-power to the railway and the ship has resulted in a power-driven commerce which is binding all nations together. Agriculture, the fundamental industry, has lagged far behind, and it is only with the occupation of practically all our naturally productive land that the problem of cheaper production has become uppermost.

The influence of power machinery upon the business side of farming should also be considered. It is evident that the small farm and individual farmer cannot compete with the power-operated farm directly, any more than the small manufacturer can maintain himself against the great corporation. Two alternatives appear; either the small farmer will be

driven out of business to become something else—as an employee of the larger organization, or possibly as a gardener, using intensive methods upon a small area for specialized and valuable products—or else he will protect himself by co-operation with his neighbor in the use of the new methods. It should be realized that one of the most effective methods of co-operation has been found to be that of the corporation, the wide distribution of stockholding interests in such cases practically making all members interested in the common enterprise. It was only by such methods that the development of railways and of steamship lines became possible, and everything points to such a solution of the problem of the efficient application of power machinery to the land.

Economy of production indicates the use of large power units, and the size of power machines and the extent of area under control will naturally be governed by natural features and local conditions. The work, may, therefore, be done by a neighborhood co-operative association or by an agricultural corporation, and the best form can be determined only after considerable experience. At the present time men of large capital are intently studying the agricultural question with a view of finding in it a possible field for investment, especially since all of the easier monopolies have been already exploited. The history of modern captains of finance has demonstrated that actual ownership of property is not essential to control. The control of credit is sufficient; and farming, like every other industry, must depend largely upon credit. Whether or no agriculture, as an industry, can be monopolized remains to be seen. Agricultural production, of course, cannot be centralized, any more than railway transportation; but its management can be, and must be, centered far more than at present.

It is evident that the large farms, operated certainly by machinery power driven, and probably under corporate management, will come first, not in the older settled portions of the country, but



Would you prefer an ancient hand pitchfork? Motor and controller operating a hay hoist.

in the West and in the western portion of Canada.

Broadly, the great advantage of mechanical power in agriculture may be summed up as follows:

Opportunity for abundant power at the time when needed without excessive burden for maintenance during the remainder of the year.

Ability to plow deeper, and to conduct the operations more nearly simultaneously, than is possible with animal power.

Ability to increase the crop production more nearly to the maximum, thus practically doubling the production, and meeting the demand for subsistence with but small increase in total cost and material decrease in relative cost.

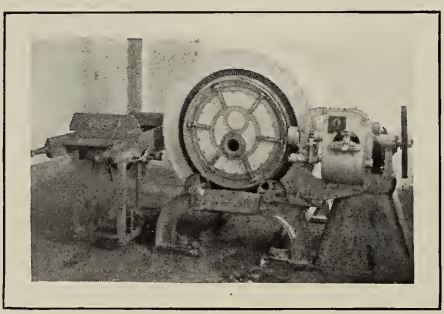
Release of human effort from the burden of excessive labor, giving opportunity for work of higher grade in more remunerative occupations.

Remunerative employment for capital invested, both in the operation of great farming corporations and in the manufacture of power machinery for agricultural service.

"THE crops from one-fifth of the cultivated acreage are withheld from supplying human needs in order to supply animal power for farming, and any increase in the proportion of animal power would increase this consumption still further."

In general, the readjustment of the great industry of farming along the lines which have already been followed by changes in manufacturing and transportation consequent upon the replacement of human and animal power by manufactured power and power-driven machinery.

The time required for these changes will depend largely upon circumstances; but when we consider the extent to which automobile transport has been developed during the past decade and compare it with the introduction of mechanical power already actively progressing on the farm, it is time for those who intend to be in the forefront of the movement to proceed with their plans.



Electricity operates this butter churn.

CITIES UNBURNABLE!

THE USELESSNESS AND EXTRAVAGANCE OF OUR ENORMOUS FIRE LOSSES

BY F. W. FITZPATRICK

A PRETTY clear case has already been made against the insurance companies by showing that, if the latter did not deliberately aid and abet arson, incendiary fires, they had, at least, a guilty knowledge of what was going on and did not raise a finger to prevent it—any noise they might have made might also have hurt their business. And where there is profit in sin it is mighty hard for humans to be really virtuous.

Fires not of incendiary origin but "accidental," occurring in the ordinary course of affairs (a very combustible course, by the way), are not encouraged, I grant you, but the companies do not hold them in horror as the general public might think they did; for those fires, as well as the others, have an element of profit in them, even though that profit be perhaps indirect. To put it in brutally frank terms, the insurance people really fear and guard against conflagrations only. In the very nature of things it is human for them not to look askance at very frequent small and some moderately large fires. They all accelerate and improve business. The losses are so distributed by their clearing-house methods that no one company suffers much, even from a big fire, and the oftener fires—not conflagrations—occur, the more certain people are to insure, for have they not the visible proof of the necessity there is of insuring their property—the ever-present danger of fire? The larger, therefore, will be the policies written, and, consequently, the larger will be the premiums. Ergo, the more fires the better; the other man's misfortune is the companies' gain.

A city composed entirely of fireproof buildings and in which only some small part of the contents could possibly burn, would offer poor opportunities for the insurance agent. Is it natural to expect those who make their daily bread, and considerable butter, and even jam, out of the insurance business, to do very

Think of what fire could do if once well started in this street! All expensive and attractive buildings but, in most part, utterly unprotected, though housing millions of dollars' worth of property and thousands of lives.

much toward the realization of such an ideal city; do you expect them to have more than lip-enthusiasm toward fireproof construction?

And yet, the travesty of it all! It is to the insurance expert that the laymen, our city authorities, our architects, and our engineers go when seeking information about how building should be done.

The power wielded by these companies is astounding, and they use it autocratically. To protect themselves against conflagration losses they never hesitate to order a city to install additional fire stations, more machines, better equipment or increased water service. The people of those cities may have begged for just such things for years and their appeals have been unheeded, but let the underwriters make these same demands and the authorities hasten to comply. That the companies generally use this power with discretion and with little abuse is greatly to their credit, although we must not lose sight of the fact that it is to their former laxity and to their willingness to insure poor risks earlier in the game that must be attributed, in great part, the conditions that now compel them, in self-protection, to demand the additional safeguards they are insisting upon.

> **"THE highly satisfactory results attained—both from the owner's and the tenant's points of view—make it certain that the modern skyscraper is to increase greatly in number, and that its maximum average height is by no means reached."**

> **"PERFECT building is absolute economy; good building is sensible; shoddy construction is positive extravagance."**

The whole problem becomes quite clear to us if we but view it rationally, divesting it of the sentiment we usually attribute to insurance and realizing that it is merely a cold business proposition. The companies are not interested in the cities' welfare or in that of their citizens. A company exists for the sole purpose of making money for its members, salaries for its officers, profit for its stockholders. When a building was erected alone in the center of a block it was not particularly exposed to external fire, and it was most natural, therefore, that the companies should make a low rate upon it even though it was built of very inferior construction. And the man built it that way because he could get that low rate and had reasons to believe it would continue so. Then, when another such building was erected upon the same block, although the danger to both was increased, the companies could still take a pretty stiff chance at the old rate, which was sufficiently "attractive" to convince a third man that that sort of construction was perfectly safe and all that he could be expected to do because, forsooth, didn't the companies encourage him to build that way by that low rate? He, too, built on this block; and later another and perhaps some of the first builders enlarged their tinder shacks. The block began to be crowded, and the companies, realizing that it was no longer a case of the possibility of having to pay for *one* building in that block, but, if fire started there, the whole lot of them were more than apt to be destroyed, naturally raised their rates *upon them all.* If another man wanted to build there he had to do it in first-class shape; anything but fireproof construction was frowned upon,

and even on that his rate was pretty high, for the companies couldn't afford to assume any more risks there, nor did they want anything to further jeopardize the risks already written. Then they turned their attention to "protection." The city was notified that it would have to put in a fire station near that block, more hydrants and greater pressure. Not that the companies gave a hang for the city's safety or the lives in it (it really doesn't matter to the companies how many people are burned) but they wanted *their* invested interests in those poorly constructed buildings protected. They had gambled with the owners of those buildings that the latter would not be destroyed and had been paid to take that chance, and it was nothing but the part of good business to in turn make the city insure *them* that fires there would be put out as soon as possible in order to minimize *their* possible losses. Figure it as you may, the cost comes back to the "ultimate consumer"; he's the "goat"; he pays the piper; likewise the insurance rates and also the taxes for the protection demanded by the companies for their interests and the losses by fire in every way, shape and manner. Stop and think how utterly stupid he is to keep on permitting both ends, as it were, to be played against him.

There are two sides to the question, of course. The companies offer the bait to gamble and the people gobble it up with avidity, hook and all. The average man, when building doesn't begin proceedings by inquiring how his building had best be constructed, but he asks: "What do the insurance companies insist upon?" He figures on the most "liberal" or slovenly way in which they will permit building for a certain rate which he deems satisfactory, and the two together form such a combination as to make possible such appalling sacrifices to the demon of fire as we have witnessed in Baltimore and in San Francisco, and that we will witness again, mark my words, in New Orleans or in Boston, and, sooner or later, though perhaps in modified form, in New York and in Chicago; conflagrations *that are possible* in every city of the Union. There has been such an orgy of bad building that, do what we can now in our newer structures, there is enough fuel in every city in the Union to give us in each—the conditions and accidents being propitious—nearly, if not quite as lively, a bonfire as occurred in Baltimore and San Francisco. Think of it; last year, in spite of all the fireproof construction that was carried on and in spite of the splendid propaganda for fire prevention, 63 per cent. of all the buildings built were of *wood!* And every one of them is or can be insured.

This architect thought it unnecessary to protect the steel work of his building, for he was convinced steel wouldn't burn, and it didn't, but——!

I blame the insurance companies for very much of this fire matter, but still more do I blame the architects. Only the most stupid layman is ignorant of the fact that an insurance company is a business concern

looking after its own interests and doesn't care a hang for him. With the architect it is an entirely different proposition. One is not buying something from him nor gambling with him. One is *employing* him to advise one how to build and what to build. The architect does have certain responsibilities in regard to his client. He is supposed to know what is right and what is wrong. Almost a public officer, he should have the public weal and his client's advantage at heart. He should know all about fire prevention and fireproof construction, *but he doesn't.* It is pathetically ridiculous how very few improvements in construction or in fire prevention were devised by architects. They seem to love the usual; the things grandpa did; precedents. It was the proper caper years ago to build with wood, so it must be all right now. Many architects think we are raising too much hub-hub about fire anyway. Others openly assert that it is bad buisness, for, if there were no fires, there would soon be no more building to be done, and therefore no work for the architects. You can count upon not much more than the fingers of one hand the architects who really appreciate the importance of fire prevention and who willingly and enthusiastically do anything toward its advancement.

It is perhaps natural that most of the progress made in the matter has been carried forward by the engineers. It is deplorable, however, that their good work should so often be nullified or spoiled by the architects. An architect will employ a good engineer to lay out the structural work of a building and the latter will take care of the fire part, too; he will direct how the fireproofing is to be done, the protection of windows, etc. But, if the bids run a bit high, it's the fire protection, the wire glass and such details that will be lopped off by the architect to cut down the expense, and this long before he touches with retrenching fingers any of the frills, the decorative features of his building. Worse than that, he will probably jeopardize the effectiveness of a very important fire-prevention feature the engineer planned, or destroy it altogether, to get in some pet whim of his; wooden wainscoting, or finish, or other gew-gaw that he thinks is artistic. He has his art on crooked, in that he forgets that the very prime purpose or function of that art is to make his building safe, convenient, lasting, and to do it with grace and refinement. When he does that and only then will he have a beautiful building. He will not secure that end by the usual method he follows. Most of his buildings *appear* very massive, attractive to the eye, prettily proportioned and impress one as being built to stand for years, if not for all time, while at heart they are but whited sepulchres—flimsy, attractive only as to externals, false, and will utterly disappear from off the face of the earth if attacked by a man's-sized fire.

It is futile therefore to expect much help from the architects, the men who should really lead in the fire-prevention movement. And the insurance companies are not going to work themselves thin in that propaganda either. And the people themselves know comparatively little about it (though there seems to be something of an awakening) and are generally apathetic about reforms anyway. So, if we expect anything big and really helpful to be done it must come through the city and state governments. Pretty nearly all that has been accomplished in that line so far has been via that route.

Hundreds of cities are now revising their building regulations or writing new ones, or have just put amended ones into force. It is well. It shows that the great fires of the past few years have not been wholly unfruitful lessons. Our people are awakened to a realization that something must be done. They are tired of having their lives and property constantly in great peril, the while paying out nearly $300,000,000 a year for fire-department and private protection and $400,000,000 a year to the insurance companies in premiums, while over $215,000,000 of property goes up in smoke every year! The cities realize, too, that prevention is what is necessary. But they are afraid to apply it thoroughly and completely. They go at the building regulations in a half-hearted way and

seek not to devise and apply what is really needed, what is necessary, but merely what "the people will stand for."

That is the ridiculous phase of it. No sooner is it suggested that better buildings will be required than there is a great howl; people declare the cost of building will be excessive; "improvements" cannot be made; it will be a hardship upon the poor man and all that sort of thing; which, in plain language, is pure rot. There has always been opposition to progress: the locomotive and the automobile were fought by the horse-dealers; telegraph and telephone were opposed. So with better building; it is opposed by the shysters who profit by poor building, the speculative builders, the jerrymen who build just so that a house stands up until they can sell it; and they have been shrewd enough to make the people generally believe that safe, reasonable building regulations were really burdensome!

Perfect building is absolute economy; good building is sensible; shoddy construction is positive extravagance. That basic fact must be remembered in devising regulations. A city full of good buildings means lessened maintenance cost for each owner, fewer repairs, a longer life for the buildings (and, in consequence, lower rents would obtain) much less expense for fire departments and water protection, and the very minimum of insurance rates and premiums, safety of life and property. It would mean millions upon millions of dollars saved and a great municipal problem solved. People should clamor for the most exacting requirements; on the contrary, they have been lied to and deceived until they really believe that the half-way measures we do apply are too severe. And our cities have been so "considerate" of the shyster-builders and have made so few exactions that, until very recently, people have been allowed to build just as they pleased—and strange, but they have usually "pleased" to build only as well as the laws compelled them to—with the result that our cities are filled with tinder-boxes and fire-traps, and that, every year or two, a third or a half or a quarter of some city or other is entirely destroyed. Day after day individual fires occur that wipe out nearly $1,000,000 of property at one fell swoop; not to mention that 2,000 or 3,000 lives are destroyed every year and over 30,000 lives imperilled every day. It is rank idiocy, imbecility; worse —it is a shame and a crime!

In spite of the senseless opposition on the part of the uninitiated—an opposition that can only originate with and is abetted by the worst type of shyster-builder—our building departments must valiantly fight for the most stringent building regulations. In that way lies safety and real progress for our cities.

A first-class city can only be an aggregation of first-class buildings. Therefore, in at least the congested districts, only perfect construction can be tolerated, the complete and total elimination of the combustible in building materials. More than that, materials that are incombustible but nevertheless damageable by fire must be protected from fire. Not a particle of structural steel must be left exposed, nor should structural concrete be left exposed. That is, in reinforced-concrete construction there should be not only enough concrete used to carry the load, but an additional thickness of concrete should be added to protect that structural portion from damage by fire. The stories must be closed off one from the other, and even each story should be sub-divided to make as small units of space as practicable in which fire may originate. Windows must be protected.

I contend that, if perfectly built and with the necessary "fire-fighting" appliances installed buildings may be built as high as owners desire, provided that the streets be not deprived of sunlight and air. This may be accomplished by stepping buildings back, so many stories on street line, so many stories above that to be built back so many feet from front, and so on up as high as one wishes.

All buildings, new and old, of a public or semi-public nature, should be conspicuously and officially labeled, designating just what classes they belong to—"First class," "Second Class," "Dangerous," etc. That will keep the building department alert in properly classifying

the buildings and will keep owners from falsely claiming that their inferior and dangerously built buildings are "fireproof."

Then the department should make every effort to have the tax system so amended that there will be a scale of rates rather than a flat rate. The owner of a first-class building, requiring the minimum of fire protection and expense on the part of the city, should pay a lower rate of taxes than the owner of the fire-trap for whose benefit and protection, and the protection of the neighboring property he endangers, the expensive fire departments have to be maintained. That man should pay the maximum rate of tax. Further, the building departments should try to secure legislation on the order of the "neighboring-risk" that exists in most European cities, whereby the individual becomes amenable for the damage done to other than his property through his neglect or carelessness. In other words, if fire extends beyond a man's own premises, he would get but part of his insurance. In Europe this works to a charm: people become most careful where they deposit ashes and waste paper and cotton waste, and all those fire-breeding things are kept in fireproof receptacles. It makes a man careful. We need it; for our Americans are proverbially and actually the most careless people on earth. Many people will clamor for as restricted fire limits as possible; the building departments should clamor for as wide limits as possible. That is wise provision, real conservatism. It is only a question of a few years when the existing fire limits of any city will have to be extended. Then they take in all the second-class buildings permitted under the old regulations, and these old ones endanger the new buildings and the latter have to be superlatively well built to withstand the adjacent fires that are sure to rage all about them in the old buildings. We must all realize that, with as rapidly growing a population as ours is, the town of today is the city of tomorrow. Every one of our cities is now suffering from an inheritance of fire-traps handed down by previous generations. The city that would make its fire limits comprehend *all* of its corporate extent would indeed be a sensible city, a really first-class city. But it is hardly to be expected that anyone of them would show that much intelligence all at once; therefore it is up to the building departments to get the next best thing by having the fire limits, the area of first-class buildings, take in just as much territory as possible.

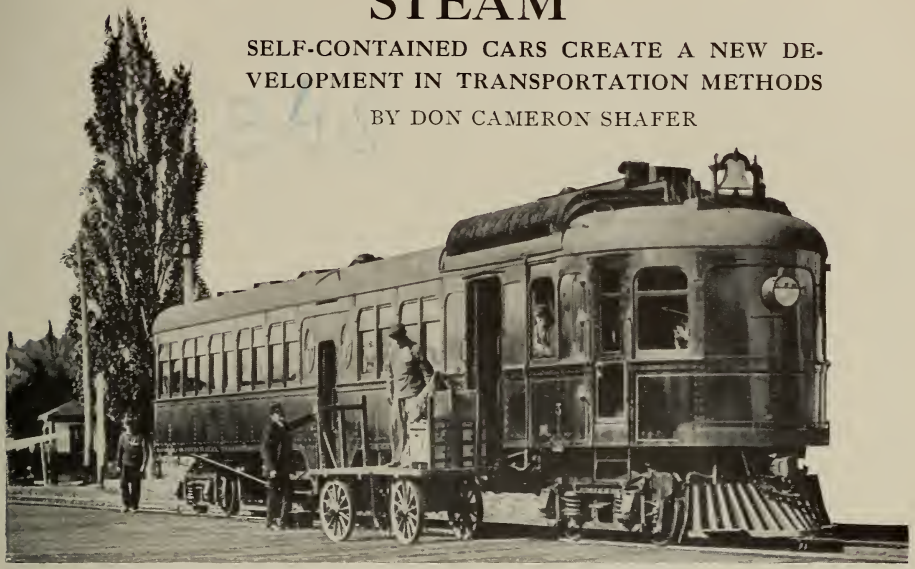
By hard work other reforms have been secured: there has been more advance made in this country in the past ten years than there was in the previous ninety. Here is a movement already well started: is not an unknown term; good hard work has been done in it, but there is yet a vast field to be covered—so far we have been able but to scratch the surface here and there.

The writing is upon the wall, but it is not a menace, not appalling; rather is it most hope-inspiring and promising, for it is writ that before long there will be cities here that are not only truly beautiful but *Cities Unburnable.*

RAILROADING WITHOUT STEAM

SELF-CONTAINED CARS CREATE A NEW DEVELOPMENT IN TRANSPORTATION METHODS

BY DON CAMERON SHAFER



Connecting link between the Main Line and the Feeder. The Gas Electric Car at the Railroad Station, ready for passengers and merchandise.

IT is a well-recognized axiom among railroad men that branch-line passenger trains never pay, and, while this is not always true, it is very seldom that a steam engine and passenger train can be profitably used for short-line work, where passengers are few.

In many thinly populated districts it is necessary to maintain the roadbed for through traffic, but it does not pay to run local trains. In other words, where branches cannot afford to operate steam trains for passenger service, the single unit cars are ideal. They make faster schedule speeds, can be started and stopped in a twinkling, and are as convenient and clean as electric cars without the added cost of a power plant, distributing lines, and overhead trolley construction and maintenance. It is for just this kind of service that the self-propelled car is most valuable, and usually it will show a profit per car mile where the steam train showed a loss.

These new cars, the very latest development in railroading, produce their own power and combine engine, baggage and passenger cars all in one. They are usually driven by electric motors which secure their energy from a gasoline engine-driven generator located in the forward part of the car, but a number of roads are using the straight gasoline engine-driven type. The storage-battery car is also announced, but they are still in the experimental stage so far as actual extended service is concerned.

One of the very first roads to use the new type of self-propelled cars was the St. Joseph & Grand Island. Since that date a number of prominent roads of the country have one or more of them in operation.

A gas-electric car of this type was re-

cently placed in service between Quebec and Lake St. Joseph on the Quebec and Lake St. John Railway, a branch line of the Canadian Northern system.

In making the trip between Quebec and Lake St. Joseph, this gas-electric car covers a distance of 22 miles, making eight daily single trips, with a total average run of 175 miles per day, exclusive of Sundays. Eight miles of this run out from Quebec are over a 1½ per cent. grade, and a trailer weighing 35 tons is hauled one trip per day from Quebec over this heavy grade. At the present writing, repairs on both the car and engine have been practically nil. The consumption of gasoline has averaged one-half gallon per mile. The car measures 58 feet 6 inches long, 10 feet 5 inches wide, and is partitioned into four compartments; one 25 feet 6 inches long for passengers; a smoking compartment, 10 feet long; baggage section, 6 feet long, and the engine cab, 12 feet long, containing the power-plant apparatus. The net weight of the car is approximately 39½ tons and it has a seating capacity for 76 passengers.

This car is, in reality, a power plant and car combined in a single unit. The power plant consists of an 8-cylinder, 4-cycle gasoline engine direct connected to a 600-volt electric generator. This engine is started by compressed air supplied by the main reservoirs of the air-brake system. The car is driven by two 100 h. p. electric motors, geared to the forward trucks, and it is controlled by the engineer in charge with the same ease and facility as a trolley car.

The Bangor and Aristook road used two self-contained cars on their summer schedule. One of these cars ran from Greenville to Milo Junction, a distance of 48.8 miles, and then on to Brownville Junction, two miles further. This car makes one round trip each day and, although it had but a ten minutes' leaway, it was not late all summer. The car is familiarly called "The Bullet," and it is a general favorite with the traveling public, who will frequently wait over a train just to ride on the new car, because it is so clean, so free from smoke and cinders, and because of its equipment of electric lights and fans.

The twin car runs from Ft. Kent to Squa Pan, 42 miles, and this has been equally successful.

Several of the Western roads have adopted gas-electric cars for short-line work where it is too expensive to maintain a steam-train schedule owing to the many stops and the small traffic. The Frisco System originally installed six gas-electric cars, and so well have they done the work that the company placed additional orders for eleven more.

One of these gas-electric cars comprises a train in itself; with passenger, smoker and baggage accommodation. The operation is similar to that of a trolley car. It is entirely independent of ash pits, coaling stations and water tanks, and can be kept in continuous service of 300 miles a day.

The cars measure 70 feet 5 inches long and are divided into four compartments; one for passengers, 33 feet long; smoking compartment, 10 feet long; baggage compartment, 11 feet long, and engine room, 12 feet long. The entire seating

A Feeder Line to a Trunk Railroad System. The Gas Electric Car on a branch line of the Missouri & North Arkansas Railroad.

capacity of each car provides for 92 passengers and the net weight of the car is approximately 50 tons. The cars are capable of running about 60 miles an hour on a level stretch and will average 25 to 35 miles per hour schedule speed with stops two or three miles apart.

The motive power consists of an 8-cylinder, 4-cycle gas engine direct connected to an electric generator, designed to meet the special conditions the service demands. The starting of the engine is effected by compressed air taken from the main reservoirs of the air-brake system, which are built with surplus capacity for this purpose.

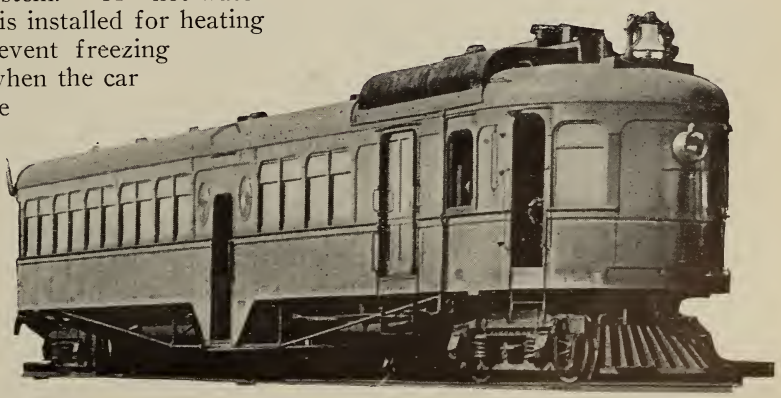
An auxiliary equipment is also provided, in addition to the regular power plant, consisting of a 2-cylinder, 4-cycle gas engine direct connected to a single-cylinder air compressor and lighting generator. The function of this set is to supply an initial charge of air for starting the engine and to deliver power for lighting the car.

Mounted on the axles of the forward truck are the driving motors, of 100 h. p. each. The brake equipment includes hand brakes in addition to the combined straight and automatic air brakes. The headlight consists of a high candle-power incandescent lamp; and an air whistle and pneumatic gong are provided, together with a standard automatic air signaling system. A hot-water heater, coal-fired, is installed for heating purposes. To prevent freezing in cold weather, when the car is lying idle, the heater circulation may be connected to the engine cooling system.

Only two men are required to operate a gas-electric car seating 90 to 100 passengers. The engine runs all the time, regardless of stops, but the car is driven by powerful electric motors geared to the trucks. The simple turning of a small lever starts, accelerates and stops the car. The operating expenses of cars of this type are only about twenty cents a car mile, including fuel, wages, supplies, maintenance, depreciation and interest in investment.

Judging from the number of unit cars already in operation the self-propelled train, for main-line work, may not be so very far into the future. The Minneapolis, St. Paul, Rochester & Dubuque line is now operating gas-electric cars with trailers. The Pittsburg & Lake Erie road has put in service a gas-electric car and trailer for work in its main four-track line. This is the first road in this country to adopt a self-propelled car for four-track service. It will be used for local runs operating between the schedules of limited trains.

The adoption of these cars has also a direct effect on new construction. Roads will be quicker to reach out into more remote districts, it is predicted; building branch lines and extensions with the idea of using the motor cars until the traffic warrants the establishment of regular steam trains. Some of the smaller trolley companies are also using self-contained cars for "owl" service.



The Gas Electric Car, carrying its own motive power, at the station on the Bangor and Aristook Line.

Car service is so infrequent on these lines after midnight that it does not pay to keep the trolley wires flooded with power.

As a matter of fact, on long interurban trolley lines of twenty miles or more, where the schedule is not less than two hours or more, the self-contained cars are more economical to operate than trolley cars.

A Feeder Line in Maine, using the Gas Electric Car.

Site of New York's Municipal Building.

WHY THE GIANT SKYSCRAPERS ARE SAFE

METHODS OF CONSTRUCTION OF THE FOUNDATIONS OF TALL BUILDINGS

BY J. F. SPRINGER

THE tall building has received its greatest development in New York City. Here a 20-story structure is no longer regarded as very tall. With the Singer Tower, possessing 41 stories and the Metropolitan Tower 50 stories, and quite a number of other buildings having in the neighborhood of 30 stories, this is not an attitude at which to be surprised. The highly satisfactory results attained—both from the owner's and the tenant's points of view, make it certain that the modern skyscraper is to increase greatly in number, and that its maximum average height is by no means reached. The development of this style of structure has introduced a number of problems, one of the most important being that of the foundation.

The extraordinary development in

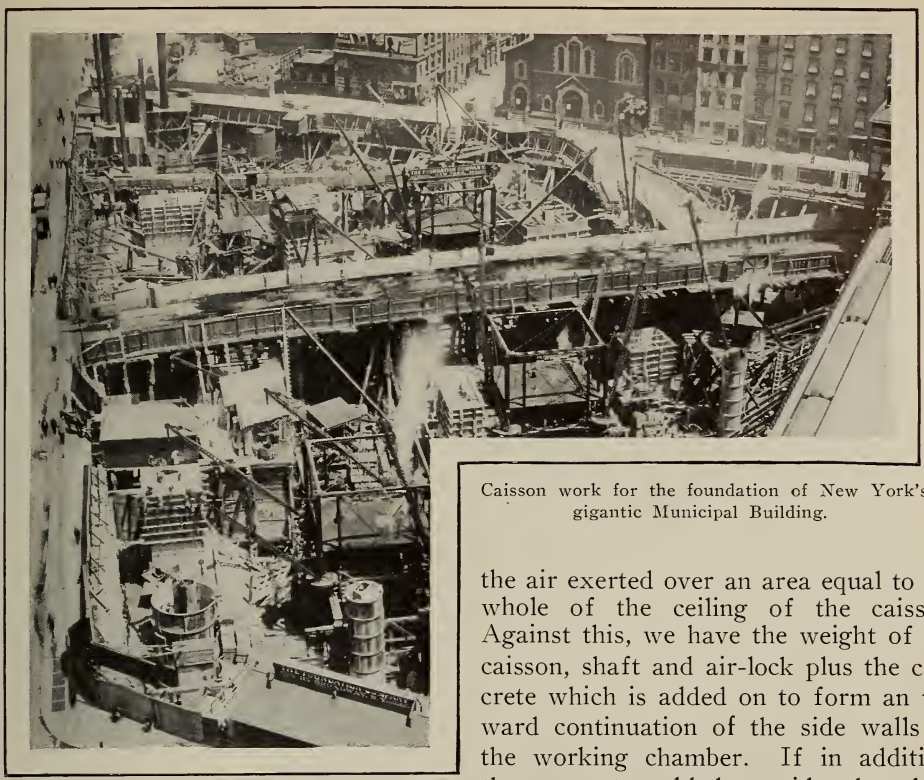
New York City has not been because of the care with which a secure foundation was to be obtained, but in spite of very great difficulties. Manhattan Island is, for the most part, a ridge of very firm rock. Speaking broadly, it is only at the southern end that the surface of this ridge dips below the street level. However, it is in just this region that the demand for the tall buildings has arisen. Indeed, it would almost seem as if no one wanted a tall building at any location where the rock was at the street level or even as high as the permanent water level. Many such locations were covered with layers and pockets of sand. Some years since, it was thought sufficient to found a pretty tall building upon piles or perhaps a mat of concrete. But such procedures are no longer approved. The foundation that is put down to-day must rest upon solid rock, or at least hard-pan.

Now the problem of getting to rock is not merely one of evacuation. That would, perhaps, present no very great difficulty. The matter must be so handled as not to disturb nearby buildings. These may not rest on bed-rock, but be floating on a pocket of quicksand. If we tapped this pocket or lowered the water level, disastrous results might ensue. Whenever material is excavated and removed, a pressure equal to the hydrostatic head must be maintained throughout and subsequent to the operation. This is the broad rule. Generally speaking, the depths to be reached are not more than 100 feet below the water level.

The pressure of 100 feet of water is equal to about three atmospheres. Now an atmosphere which is so dense that it contains about three times as much more air than that to which we are ordinarily accustomed has a tension which is just about the limit of human endurance. It can be borne, however. By the use of compressed air, we may, accordingly, within the limits of 100 feet below water, put a workman at the point of evacuation and exert a restraining influence in every direction equal to the hydrostatic head.

We must not assume too quickly, however, that 100 feet below the water level is the limit of the pneumatic method. It is very true that we cannot oppose a higher hydrostatic head than about 100 feet. But other conditions may intervene. Thus, in constructing the foundation piers for the Singer Tower, a very solid bed of hard-pan was found to overlay the rock. Under such conditions, if the hard-pan is really impervious to water, one of two procedures may be adopted. The excavation may be continued without increasing the air pressure beyond that which corresponds to the level of lowest penetration of water. Second, the caisson may be carried well within the hard-pan and thoroughly sealed to it to prevent the intrusion of water. The air pressure may then be withdrawn, however, if there is uncertainty as to whether water may have penetrated to lower level in the immediate neighborhood. However, the sealing must be done in strict correspondence to the hydrostatic head. In general, it is best to have an air pressure never less than that of the hydrostatic head at the point of lowest evacuation at the moment. Ordinarily, the pressure is left a little in excess.

A typical pneumatic caisson is a very strong box without a bottom. There is an opening in the roof. Here the shaft is located. The caisson itself may be of wood, steel, or reinforced concrete. The shaft is ordinarily of steel. It is made in sections with interiorly projecting flanges to permit securing them one to another. Each section may, further, consist of a number of segments which have been bolted together, interior flanges being used here also. The shaft may be entirely disassembled from within.



Caisson work for the foundation of New York's gigantic Municipal Building.

At the top of the shaft is arranged an air-lock. The lower edge of the caisson, or working chamber, may be fitted with a kind of sharp shoe to facilitate penetration. Excavation is carried on by workmen—"sand hogs"—operating from within the caisson. As they dig away the soil and lower depths are reached, the air pressure is increased for the purpose of opposing the entrance of water either on the floor or around the sides. This water is pressed in by the hydrostatic head above it, so that the opposition pressure must be at least equal to it.

On the roof of the caisson, some kind of masonry, usually concrete, is added outside the shaft. This forms a wall and supplies a much needed weight. From the air-lock down the shaft to the floor of the excavation we have a body of compressed air. This exerts its pressure equally in *all* directions, and everywhere. There is an upward pressure of the air exerted over an area equal to the whole of the ceiling of the caisson. Against this, we have the weight of the caisson, shaft and air-lock plus the concrete which is added on to form an upward continuation of the side walls of the working chamber. If in addition, the concrete added outside the shaft does not cover the roof, then we may at times have a very considerable net upward pressure.

The skin friction of the concrete walls against the side of the excavation may be great. It is customary to use large blocks of pig iron as a temporary weight. A little consideration will show one that there is a very considerable upward thrust exerted against the air-lock. This will be felt at the points where it is attached to the shaft and where the latter has its section bolted together. It is of the highest importance that nothing shall give way and let the precious compressed air out. A sudden discharge of the compressed air, or even a considerable reduction of the tension may result in the drowning or crushing to death of the men in the caisson.

Of course, the compressors which supply the air constitute a very important part of the equipment necessary to

this method of excavation. The air pressure corresponding to a hydrostatic head of 100 feet is about the limit of what a man can endure. This is about 43½ pounds, or perhaps a little more. However, pneumatic evacuation under a higher hydrostatic head was done in connection with the founding of the piers for a railway viaduct over the River Barrow in the southern part of Ireland. Here a depth 120 feet below high water was reached. An air tension competent to resist such a head of water would be 52 pounds or more per square inch. This is 7 pounds in excess of what ought to be the limit. The difficulty was dealt with in this case by limiting the air pressure to 45 pounds and employing ejectors operated of course under high pressure to resist the entrance of water beneath the edge of the caisson. Whether the use of ejectors would be sufficient under most conditions, I do not know.

As the caisson goes on down and the concrete wall grows, it is necessary for workmen to enter and leave and for empty vessels to go down and full ones to come up. That is to say, there must be a satisfactory way of getting into and out of the region of compressed air. The device by which this is accomplished is the air-lock. It is, essentially, a compartment fitted with an upper and a lower door. Both doors may open downwards. A strong excess upward pressure will maintain either one in a closed position. With equal pressure above and below it, such a door can readily be opened, if shut; or closed, if open. If the lock is to be entered from the outside, the lower door must first be closed. By exhausting the air in the lock, the upper door may readily be opened, and the chamber entered. The upper door is now closed, and the lock connected with the body of compressed air in the shaft. The lower door may now be opened, and a workman may descend into the shaft itself. By going through the same cycle of operations, another may be permitted to follow; by going through a similar set of operations, one may pass out. The passage in or out should not be made suddenly. With materials, buckets, and the like, the same procedures are followed, omitting of course any delays in the lock. Indeed, the design of locks has proceeded far enough now so that it is not necessary to disconnect a bucket from the supporting rope while in the lock. No one needs be present in the lock to assist the passage of the bucket. The whole operation of the passage can now be performed with great celerity and certainty.

When at last, the desired bed-rock has been reached, and a continuous wall of concrete constructed from the roof of the caisson to the upper surface, it remains to remove the shaft and fill up the entire interior space with concrete. It may be necessary to seal the floor with a heavy slab of concrete before the compressed air is permitted to escape. An objectionable feature is the presence of the roof of the caisson in the finished mass of concrete. Perhaps this would, in most cases, be perpetually submerged. However, this seems a doubtful kind of thing to leave

"LAND is so immensely valuable in the big centers and the tendency of business is so pronounced toward centralization, congestion, that the tall building is inevitable. It is profitable and therefore is bound to be.

"The tall building must be superlatively well built. Property owners realize that, and the architects and engineers are responding to the demand. A tall building perfectly constructed and equipped with its own water-supply and fire-extinguishing apparatus, such as the Singer Tower, the Metropolitan and the Woolworth, for instance, is as safe as any three-story or four-story building, and infinitely *safer* than most of the 200-foot ones. It is also absolutely independent of fire department limitations. It *has* to be self-reliant, being beyond ordinary help; therefore the law—self-interest—*every* motive compels it to be so built as to warrant that reliance upon its own excellence.

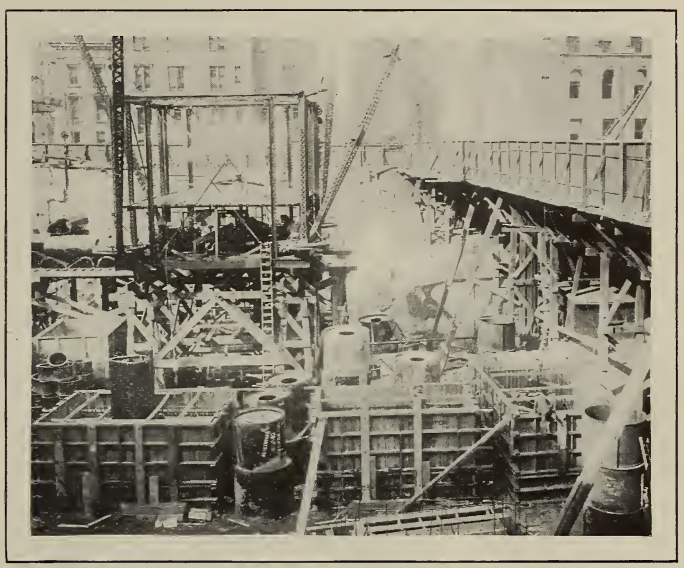
"The tall building can be made, and a lot of them are, artistic, beautiful. It is distinctively American; therefore the real opportunity we have of giving to the world a distinctively *American* art!"

—*F. W. Fitzpatrick*

in a foundation pier. It has been found possible to deal with this objection in the following way, a method which was adopted in connection with sinking the piers for the United States Express Building, in the financial district of lower New York. A temporary wooden roof is constructed for the caisson. On top of this steel angle bars are laid. A layer of concrete may now be put in position, and indeed made quite thick. When the concrete becomes hard, the wooden deck may be removed. In fact it is said that by giving attention to the form of the steel bars they might also be removed.

The shell of concrete surrounding the shaft is ordinarily put in position above ground, and the forms are removed before the surface is reached or shortly afterwards. When bed-rock is reached the pier is thus nearly completed. This is a very important consideration in operating rapidly on a contracted site. Foundations may now be sunk by this general procedure in a very short time. The method is also one of great certainty. It is somewhat expensive; but, in view of other advantages, this is scarcely to be considered when operating through quicksands in a large city with heavy buildings nearby.

Some problems seem to defy any commercial solution. Such a case occurred in connection with the foundation construction for the Municipal Building at New York. This structure has a height of 25 stories and a tower. A number of wash borings were made and indicated rock at about 100 feet. When, however, a more thoroughgoing investigation was made, it was found that the rock on portions of the site was as far down as 131 and 177 feet below the water level. Such depths were beyond the limits of the pneumatic-caisson procedure. Some thought was given apparently to the question of employing the freezing process, or the injection of cement grout. Both were regarded as rather uncertain. The final solution of the matter was to found about one-third of the building on sand, the corresponding caissons being carried to about 40 feet below the water level. About 68 caissons were carried to rock at a cost of about $1,000,000. There are 38 concrete piers founded on sand. These are calculated for a pressure of 6 tons per square foot. The entire building, 337 feet high for the most part, and 560 feet at the tower, is estimated to weigh about 165,000 tons.



Showing outside forms for reinforced-concrete caisson. This is probably the first practicable application of this type of pneumatic caisson.

Where conditions are favorable, the cofferdam, or open caisson, is perhaps as useful an auxiliary as the engineer could wish. Thus, the situation may be such that no harm will be entailed by the removal of large quantities of water. A caisson equal in plan to a part or the whole of the site may be built up to a fair height on the spot. This caisson will perhaps

have a sharp cutting edge. It is then often merely a matter of excavating from within, either by hand or by the use of grab buckets. It may be necessary to control the descent of the caisson. This may be done by the use of exterior guides and of hydraulic jacks.

In cases in which clay overlies the rock the sheet pile appears to furnish an advisable means of constructing the cofferdam. If there are structures in the neighborhood which would suffer from the disturbances consequent upon heavy driving, the steel sheet pile may be employed. Such piles have usually only a very slight cross-sectional area and may be driven with but little shock. At the beginning of the present century, a very heavy type of sheet piling was driven in Chicago close to the old Linn Block. The alternate units of this sheeting consisted of two 15-inch channel bars bolted together face to face. These piles weighed upwards of 67 pounds per vertical foot. Two hundred girls worked in the Linn Building during the operations. This piling is made in such designs as already to be fairly watertight or capable of being made absolutely so. There are a number of forms of American steel sheet piles that are provided with strong interlocks. Consequently, we have at once what is in effect a diaphragm of steel. The procedure is quite simple after the piling has been driven around the area desired. The material is removed by any suitable means. If necessary, the sheeting can be braced as the evacuation goes on. Any water present is simply pumped out.

Circular pier in foundation of Woolworth Building.

In constructing the Steele-Wedeles Building in Chicago, a large cofferdam, 40 x 132 feet, was constructed of steel sheet piles, driven in 45-foot lengths. The site adjoined the Chicago River. Heavy wooden beams were employed to brace the structure interiorly. By this means a sub-basement five stories deep was constructed. Whatever the application in the present case, we have here an example which shows how the foundations themselves may be placed.

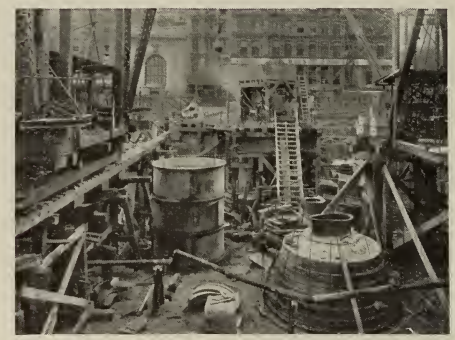
One of the most considerable examples of difficult foundation work in New York City occurred in connection with the construction of the Hudson Terminal Building. Above ground, there are two similar and—but for a passageway at the third floor—separated buildings. These tall structures are used as office buildings. They are quite important buildings, as may be judged by the fact that they are together equipped with a total of 39 elevators. Below ground there is a great concourse, also the end of a terminal loop of the Hudson & Manhattan Railroad, and a power station, at different levels. The concourse and terminal tracks correspond to the combined sites of the buildings above ground and of the intervening city street. In short, we have here a very deep and large excavation. The soil in this neighborhood is waterbearing. A cofferdam was put in place enclosing the whole, but it was thought desirable to go on with the superstructure without waiting for the very considerable amount of evacuation that had to be completed ultimately. It is possible that this desire was based on the advantage of making the office buildings productive of an income at the earliest possible moment. But, whatever the reason, it was necessary to provide a foundation in advance of completing

Foundation work of Bankers' Trust Building, Wall and Nassau Streets, New York City.

the excavation. So at the proper locations scattered over the whole area, pneumatic caissons were put down. These consisted in part of great headless barrels. The "hoops" were on the inside, however, so as not to interfere with the descent of the caissons through the soil. A suitable shaft and air-lock was rigged up in connection with these and the evacuation carried on as is usual in pneumatic work. When the proper point was reached, the barrel-like casing would be sealed at the bottom and the compressed-air paraphernalia withdrawn. There was now provided a deep hole and a suitable and firm footing at the bottom. A metal base and a steel column was now put in position in this cavity. The wooden sheathing still remained. As the construction of the various underground floors was carried out, these wooden tubes were cut away, the procedure being from the surface down.

The conditions that obtain in Lower Manhattan are, it would seem, just about the reverse of what they are in the business section of Chicago. In both, the rock is often far below street level. In New York, one may look for a hard-pan stratum immediately overlying it; above this will be perhaps a layer of quicksand. In Chicago, however, the waterbearing stratum is to be looked for below the hard-pan and above the rock. This waterbearing layer may be anywhere from a few feet to a score of feet in thickness. It consists of sand, gravel and boulders. From one point of view, it does not present the same difficulty as is found in New York. In the latter city, the engineer has to contend with a genuine fluid quicksand. In Chicago, it has been found possible to deal with conditions by means of a kind of open "caisson." As the soil is ordinarily stiff enough to hold up while an excavation is being carried a few feet, the procedure consists essentially in digging a circular hole or shaft for a short distance. The diameter will be, say, 4 feet or something more. Wooden lagging is now put in, planks 3 inches thick and 4 inches wide being appropriate dimensions. These planks may be perhaps 4 or 5 feet long.

They are arranged vertically and are kept in position by means of rings of iron, as we are informed by Mr. W. C. Armstrong. Two such rings are put in place to hold the lagging of a section. As the excavation goes further and further down, the lagging is added to and the "caisson" increased in length. Sometimes the footings of the piers are to be situated in the hard-pan. In such cases, it is approved practice to enlarge the diameter at the lower end of the excavation. This enlargement, however, is made subsequent to the arrival at the final level, the bottom lagging being removed for the purpose. It is recommended that the slope of the bottom "bell" should not be less than 45 degrees. When the "caisson" is to be carried all the way to bed-rock, the lagging may require to be placed in quite short lengths because of the danger that the ground may cave in. For the same reason, it is not advisable to attempt to remove the bottom lagging for the purpose of enlarging the bottom of the shaft. It is said that the final excavation when the rock is close at hand is apt to be a matter of anxiety. When the rock is reached concrete is put in place. It is customary to take out the iron rings as the concrete is placed, so that they may be used again. It is considered the better practice to take out the lagging as well. The concrete then conforms to the precise surface of the excavation. Lateral friction between the pier and the soil is thus increased. However, conditions may be such as to forbid removal of the sections of lagging. The soil is removed by buckets which pass up and down the shaft. In a typical case, the winch head which operates the bucket rope is continually in motion. It is interesting to note the method of driving the winch heads. The steel rope from the ordinary hoisting engine will be given one turn about a sheave keyed to the same shaft as the winch head. The same rope may then pass to the sheaves corresponding to other caissons. The ends of the rope are then spliced together. The caissons need not be in line, as the rope may be directed by guidewheels. In this way, three or four caissons may be served by one engine.



Showing inner form and reinforcement for reinforced-concrete caisson. The Woolworth Building was the second job on which this type of pneumatic caisson was applied.

WHAT MAKES COMMERCE?

HARBOR DEVELOPMENT AND DOCK EFFICIENCY ARE THE KEY TO FUTURE GROWTH

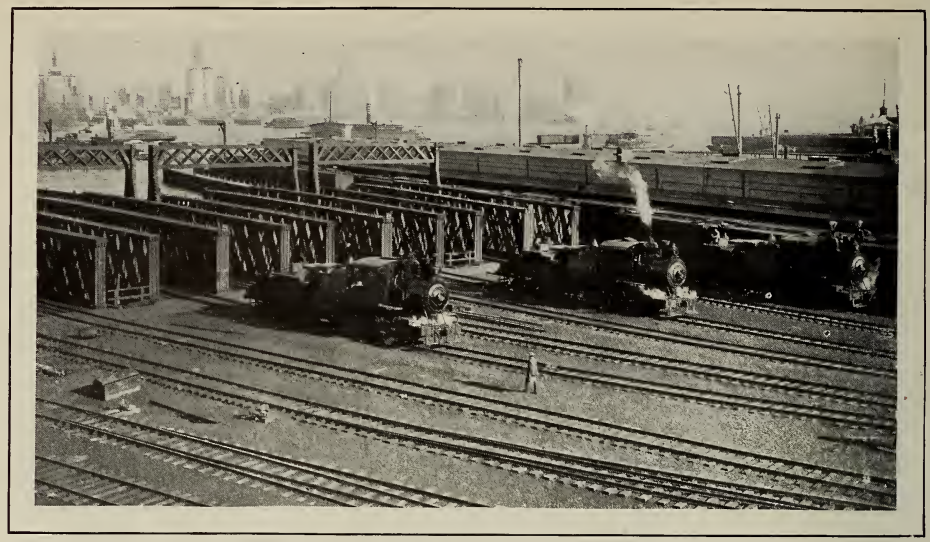
A SYMPOSIUM OF OPINIONS

The Harbor of New York

A Symposium of Opinions Expressed by Hugh Bancroft, Chairman Directors, Port of Boston; Calvin Tomkins, Former Commissioner af Docks and Ferries, New York; Henry R. Towne, President Merchants' Association of New York; Emerson E. Parvin, Secretary of the International Mercantile Marine Company, New York; Irving P. Bush, President of the Bush Terminal Company, New York; Charles E. Heitman, General Manager of the Debenture Corporation of New York; Cesare Conti, Banker, Importer and Important Official of the Lloyd Sabaudo Steamship Line, New York; W. Van Doorn, Manager Holland-America Line, New York; George W. Norris, Director Department of Wharves, Docks and Ferries of Philadelphia; Tiley S. McChesney, Assistant Secretary and Treasurer of the Board of Port Commissioners of New Orleans.

THE question of the limitations imposed upon shipbuilding by the present conditions at the various harbors of the United States formed the subject of an editorial in this magazine nearly a year ago, and it was there shown that if the present rate of growth continued, the thousand-foot steamship might be expected about the year 1920. This rate of growth, however, appeared to be less rapid than formerly for reasons wholly unconnected with the art of shipbuilding, i. e., because the limitations of harbor capacity are being rapidly approached. The following extracts from the editorial published in these pages in July, 1912, will be found to be effectively supplemented by the symposium of opinions from eminent authorities whose views are given concerning the ports with which they are especially familiar.

"The two great gauges, so to speak, of the draught of vessels, are the Suez Canal and the Panama Canal. At Suez, the increasing demands of traffic have caused the waterway to be repeatedly enlarged, and the works now under way will provide a depth of 36 feet of water, permitting steamships with a draught of 31½ feet to pass. This work, however, will not be completed until the close of 1913. The Panama Canal, which will doubtless be able to pass vessels about the same time, although it is not to be opened officially until 1915, will have a minimum depth of 45 feet and be able to receive vessels drawing 40 feet of water. Notwithstanding the fact that these great



Landing Piers for Freight-Car Floats in New York.

The locomotives are waiting to pull the cars from the floats to the tracks in the freight yards.

waterways have not as yet been called upon to receive the greatest of modern vessels, it is entirely possible that such demands may be brought upon them, and with such developments in sight the shipbuilder will have to keep these limitations of draught, with their influence upon other dimensions, continually before him.

"Leaving for the moment, the fact that the commerce of the world must in future be carried in vessels which can pass through either or both of the great canals, we may consider the limitations of the principal terminal harbors. At the present time the greatest trans-Atlantic liners are in the service between Liverpool or Southampton and New York and between Bremen or Hamburg (or rather Bremerhaven and Cuxhaven) and New York. At the New York end, the Ambrose channel is supposed to provide a depth of 40 feet, but this is within comparatively narrow limitations; but we may assume a maximum depth for New York of 40 feet at low water and 46 feet at high water. The British ports, owing to the greater range of the tides, offer more marked differences than New York, the depths at Liverpool, for example, being 54 feet at high tide and 37 feet at low tide, while at Southampton the depth, until recently, was only 32 feet at low tide and 45 feet at high water. The new deep-water dock, however, constructed for the *Olympic* and vessels of the same class, provides a depth of 40 feet at low water, with an additional 13 feet at high tide. The maximum low-water depth at the London docks is 30 feet, but the importance of providing better accommodations is indicated by the fact

"THE best equipped piers, however, under the most capable management, cannot properly serve their purpose without the railroad facilities to bring and to take away the commerce that passes over them. In most ports this necessity is met by providing a belt-line railroad with tracks to both the piers and the warehouses, and having the outlet to all the trunk lines that serve the port."

that the proposed newer docks are to have a low-water depth of 38 to 44 feet.

"The new harbors at Rotterdam are to have a minimum depth of 33 feet, corresponding to 38 feet at high water, while at Antwerp the present harbor offers a depth of 30 feet, with a proposed increase to 37 feet.

"These facts all indicate that the next great public work to be undertaken by the principal maritime nations will be the improvement of harbors, and especially the deepening of channels. The Panama Canal construction works have been only the beginning, and, unless the principal harbor entrances are improved to correspond, the limitations of commerce will appear everywhere else. The engineer will have to provide methods to open channels, and, what is more, to keep them open. Dredging will do part of the work, but the conditions which have led to the formation of bars and the shoaling of harbor entrances should be studied, and the forces which have acted to move the mud and sand in undesired directions may be enlisted to scour out and maintain passages which will keep the channels open.

"Probably the best results will be attained by a combination of both methods, using modern powerful dredges to cut deeper channels, and also by constructing properly designed reaction breakwaters to direct the ebb and flow of the tides to deepen still further the waterways and prevent shoaling of the work already done. Until the harbor engineers upon both sides of the ocean act in concert with the builders of vessels to provide channels commensurate with their work, it will be useless to attempt to predict the developments in shipbuilding for coming years."

PRESENT CONDITIONS OF THE PORT OF BOSTON.

(HUGH BANCROFT, CHAIRMAN DIRECTORS, PORT OF BOSTON.)

"Boston is one of the finest natural harbors in the world, and though the steamship piers are only an hour from the open sea, the harbor is perfectly protected by islands so disposed as to form natural breakwaters.

DEEP AND WIDE CHANNEL

"The Government has, without difficulty, dredged a channel 35 feet deep at low water (44½ feet deep at high water) and 1,200 to 1,500 feet wide. The piers at present used as terminals for ocean-going steamships, are owned by Boston's three railroad companies and supplied to steamship companies free of rental. Boston has, fronting on a depth of at least 30 feet of water at low tide, a lineal frontage of over six miles of berth space.

COMMONWEALTH PIER 1,200 FEET LONG

"In 1911 the port of Boston was put in charge of a State Board of Port Directors, who were given an appropriation of $9,000,000 to provide further facilities. The Board inherited several hundred acres of the made land and submerged flats, easily filled in, on the waterfront of South Boston, the choice situation in the harbor for an ocean terminal. Here there has been erected the new Commonwealth Pier, 1,200 feet long and 400 feet wide, the only suitably situated pier in any of the North Atlantic ports that is at present large enough to receive the monster liners (such, for example, as the S.S. *Imperator*) that are to sail from Europe next spring.

"This pier is the first of a series of State-owned piers in Boston. Adjacent to it the State is constructing and leasing to the Boston Fish Corporation a similarly large pier. The amount expended on this pier and the structures upon it will total $1,500,000.

$2,500,000 FOR PIER SHEDS

"The Directors are expending $2,500,000 in the construction and equipment of three enormous pier sheds on the Commonwealth Pier, in the laying of railroad tracks upon these piers and in the building of a viaduct to form a connection be-

tween one of Boston's main streets and the second story of the central pier shed, which will contain the finest passenger accommodations on the Atlantic coast. The west half of this pier will be used by the Hamburg-American Line; other steamship lines are negotiating for the remainder of the pier.

NEW BOSTON-HAMBURG SERVICE IN 1913

"As Boston is 200 miles nearer Europe than any other of the large ports, its location as a terminus for passenger lines is especially desirable.

"The Hamburg-American Line has decided to institute in the spring of 1913 a Boston-Hamburg service with the passenger steamers *Cleveland* and *Cincinnati,* each of 17,000 tons, adding the *Amerika* (23,000 tons) in 1914 and the *Kaiserin Auguste Victoria* (25,000 tons) in 1915. These steamers will call at Cherbourg and Southampton on their way to Hamburg. They will be in addition to the passenger lines which Boston now has to Great Britain and the Mediterranean.

"The Directors of the Port of Boston have recommended the construction of a dry dock large enough to accommodate any liner afloat.

"We have reason to feel that in Boston is arising the second American world port to which the greatness of this country's foreign commerce is entitled.

THE PORT OF NEW YORK.
CALVIN TOMPKINS, FORMER COMMISSIONER OF DOCKS AND FERRIES OF NEW YORK

"Of late there has been a cry that the supremacy of the port of New York is waning, that it is threatened by the new activities of port development at Boston, Philadelphia, Baltimore and other Eastern seaports.

A GOOD CRY TO STIR NEW YORK'S CITIZENS

"It is a good cry to awaken the heretofore uninterested community to the country-wide interest and movement for modern seaport terminals; a good cry to stir the imagination of New York's citizens and bring realization of the ever-present opportunity for increasing her wealth and maritime greatness.

"I am told that some of the hasty have read a disparagement of New York into my three years' campaign for gathering up the various units of this great port into one highly efficient, inter-related terminal. I have never questioned the pre-eminence of the port of New York; it is supreme, and, in my opinion, will always be by far the best harbor of the New World. I have asserted, though, again and again that the efficiency of the present port, its more ready expansion, its cheapness as an entrepot, the cost of food and necessaries to its citizens—that all these would be materially improved by linking up its separate terminals, its independent piers, its waterfront industrial centres, and thus accomplishing a terminal through which freight could freely flow.

748 MILES OF AVAILABLE HARBOR FRONT

"Few know the far-flung line of piers, the terminals and the factories that make the port of New York the ranking port of the world. By the port of New York I mean not only the waterfront of the five boroughs of the Greater City, but

"I THINK that the recent experience of a Philadelphia shipper illustrates my meaning. After holding a chartered vessel for forty-eight hours beyond its originally scheduled sailing date, in order to give her a full cargo, he was compelled to order her departure minus scores of carloads of freight which were already within the port, but which the railroads, because of inadequate yard and belt-line facilities, could not get to the pier for perhaps several days. Naturally such delays means losses, and ultimately these losses fall upon the consuming public."

also the long New Jersey shore line across the bay—in all, 748 miles of harbor front available for ready improvement. Of this great coast line, some 120 miles have been improved, and present for the needs of commerce and industry 357 miles of wharfage at piers available during all stages of the tide. At how many other harbors in the world can the *Mauretania* or the *Lusitania* come in at sundown or leave at midnight, regardless of tide or weather?

232 MUNICIPAL PIERS

"It is stated that the combined wharfage of Boston, Philadelphia, Baltimore, New Orleans and San Francisco is but 92 miles of quays and piers—that of New York, 357 miles. In municipal or public work the five ports offer some 75 piers—the city of New York, 232 piers. These latter are the piers of the city, constructed and maintained through its Department of Docks and Ferries.

$25,000,000 INVESTED ON CHELSEA DOCKS

"The greatest of all passenger steamship terminals are the Chelsea docks, including 9 piers in the North River, between Gansevoort street and Twenty-third street, representing a municipal investment of $25,000,000. On the second floors of these piers are landed thousands of first and second-class passengers year in and year out. Each of these upper floors is comparable alone to the great concourse of the largest railway stations. On the lower decks are handled thousands of tons of freight from the many lines of express steamers to all parts of Europe. The acquisition of even a branch of one of these lines is considered an achievement by the other ports of the country; many of the ports of Northern Europe take pride in being the headquarters of only one of these great companies that are all concentrated and accommodated at this terminal.

FREIGHT PIERS 1,600 FEET LONG

"Aside from the two hundred and nine piers of usual length the city has just constructed two fine freight piers, 1,400 and 1,600 feet in length, at South Brooklyn. These are but the beginning of the city's part in a great seaport terminal of the future—an enterprise which now exists in the miles of piers, railroad tracks, warehouses and factories of the Bush Terminal and of the New York Dry Dock Company.

"Three large ferry terminals and another one building, and ten ferry boats, stand for the city's investment of some $10,000,000 to provide ferry service between those sections of the harbor neglected by the private companies that operate from twenty-five other terminals.

"For the last few years the city has denied the port moneys, save for the routine of repairs, maintenance and a few small piers. In 1911 the normal yearly expenditure was $1,275,000 for payrolls and up-keep alone. At many ports one such sum for the harbor appropriation would cause wide comment.

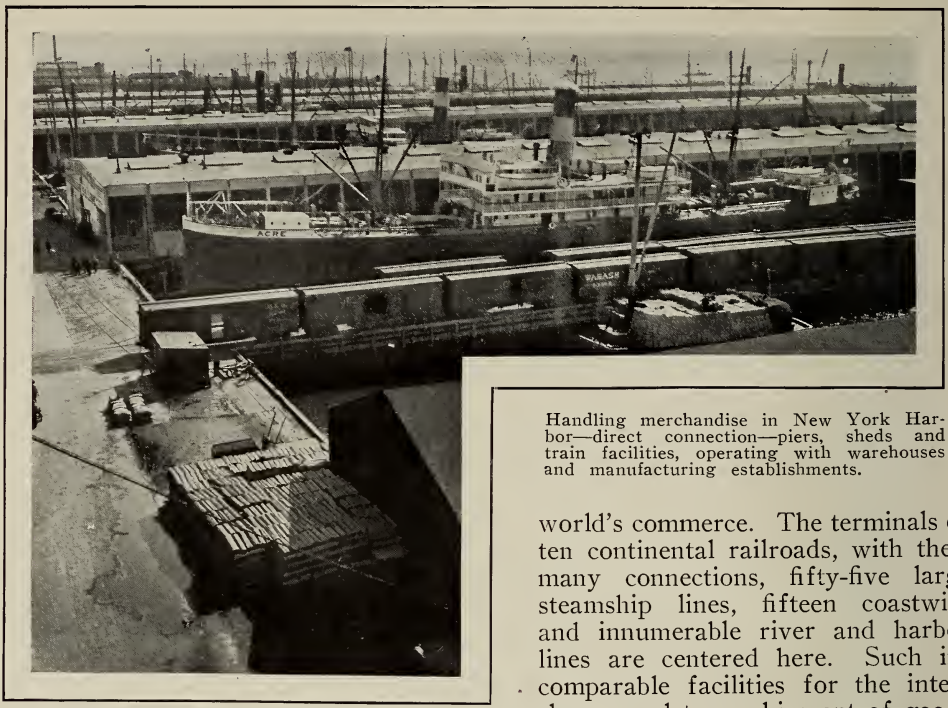
"THE proposition about trans-shipment facilities and charges seems to be this: That, while our railroads and our steamships have been developed to their highest possible efficiency by the use of modern improvements and inventions; while they are being operated for speed, capacity and all that those two things mean in the saving of time and money, the gateway through which commerce must pass between them—the port—has not kept pace in improvement."

$109,473,000 EXPENDED BY NEW YORK IN HER PORT SINCE 1870

"In all, since 1870, the city alone has spent $109,473,000 for the port; over against this are the larger millions of private enterprise."

PRACTICALLY NO DEVICE FOR HANDLING FREIGHT WANTING

"The superficial often inquire for the mechanical equipment and method of



Handling merchandise in New York Harbor—direct connection—piers, sheds and train facilities, operating with warehouses and manufacturing establishments.

handling freight so prominent to the eye in European ports. From a high belfry or cathedral tower most of these ports lie entirely within a sweep of the eye, their mechanical equipment and sheds standing out clearly and, in the mass, producing a striking appearance. Here in New York, along the hundreds of piers and miles of waterfront mechanical appliances are numerous. Practically no device for the handling of freight, its assemblage or transference is wanting in the equipment of the harbor; but scattered as they are, throughout the great length of its shore line, they fail to produce that striking appearance which causes comment by the casual observer in Northern Europe.

EMBARRASSMENT CAUSED BY GREATNESS

"It is in the very greatness of the port of New York that its embarrassment lies. Individual ships, great mercantile lines, railroads—all are crowding in upon New York to secure the advantages to their business of so great an assembling point, to have a depot at the great exchange market of the world's commerce. The terminals of ten continental railroads, with their many connections, fifty-five large steamship lines, fifteen coastwise and innumerable river and harbor lines are centered here. Such incomparable facilities for the interchange and trans-shipment of goods make an ever-increasing demand for more wharves. Today on the files of the Department of Docks alone there are over thirty applications for piers, or even parts of piers. The failure to meet these demands, the failure to supply facilities for these applicants, the failure to build excess piers that will create business to occupy them—these make criticism of this great port pertinent.

DEMANDS FOR NEW PIERS MUST BE MET PROMPTLY

"These demands must be met and piers built to create a still greater demand. Further, there must be provided connecting railroads so that the port will be most effective as a terminal and cheapest as an entrepot. It is this element of efficient harbor organization that is so badly needed at New York. Other ports are smaller but better balanced machines; in actual capacity insignificant by comparison, but in comparison of efficiency far superior.

"Water-borne traffic has free and untrammeled passage throughout a harbor. In the same way, behind the docks and piers merchandise and goods should

freely circulate and pass between the different sections of the harbor and the hinterland. The arteries of this free circulation behind the docks are marginal or connecting railways, with proper assembling yards made more efficient by warehouses for storage of goods in transit; and, behind all, properly located industrial or factory centres. It is for these factors that the Department and myself have been striving with great emphasis during the past three years. We now have plans for a marginal railroad at South Brooklyn to serve the piers and the factories; plans for a marginal railroad for the West Side of Manhattan; one for the Bronx—in fact, for each section of the port.

> "FEW know the far-flung line of piers, the terminals and the factories that make the port of New York the ranking port of the world. By the port of New York I mean not only the waterfront of the five boroughs of the Greater City, but also the long New Jersey shore line across the bay—in all, 748 miles of harbor front available for ready improvement. Of this great coast line, some 120 miles have been improved, and present for the needs of commerce and industry 357 miles of wharfage at piers available during all stages of the tide. At how many other harbors in the world can the *Mauretania* or the *Lusitania* come in at sundown or leave at midnight regardless of time or weather?"

IMPRESSIONS OF AN INDUSTRIAL LEADER

HENRY R. TOWNE, PRESIDENT MERCHANTS' ASSOCIATION OF NEW YORK

Mr. Henry R. Towne, President of the Merchants' Association, says:

"New York is unique among the great cities of the world in the character of its harbor and the extent of its riparian lines. The great extent of its deep waterways, however, while giving it unrivaled accessibility for water-borne cargoes, creates difficulties greater than in any other case, in the handling of cargoes intended for interior distribution by rail. Only one trunk line of rail available for freight enters Manhattan. Over all other west-bound lines freight must enter and leave New York by water carriage, usually by cars on floats.

CHANGED CONDITIONS MUST BE MET

"The conditions thus arising as to inland connections have always been a handicap, but thus far have been outbalanced by the facilities afforded to shipping entering the harbor of New York. The character of that shipping, however, has changed profoundly, and greater changes are impending. Unless the harbor facilities are modified and improved to meet these changes, as is being done by competing ports, the supremacy of New York harbor will disappear. Simultaneously with these changes in the city itself and in the volume and character of the freight it receives and sends out, which have caused a great increase in the cost of receiving, transferring and reshipping merchandise of every kind which enters or leaves Greater New York. Already this increasing cost and decreasing efficiency constitute a heavy burden upon the inward and outward commerce of the city and a serious handicap upon its merchants and shippers as against those of other competing cities and ports. Fortunately, the public is beginning to understand and appreciate these facts and is ready to approve and support any well-devised plan for the solution of these difficulties whenever assured that it is the best available and that it will ultimately accomplish what is required.

FUNDAMENTAL REQUIREMENTS

The three fundamental requirements in Mr. Towne's opinion are:

"First—Docks adequate to receive the largest vessels now afloat or projected and conveniently accessible both for freight and passenger service.

"Second—A marginal freight railway, probably elevated, extending to all important piers, including those for floats, leaving the surface roadway unobstructed and available for vehicle traffic, with a series of abutting warehouses behind the marginal railway, with spurs from the latter entering them, within which incoming and outgoing freight may be received, classified, assorted and reshipped without the intervention of teaming.

"Third—One or several classification yards, common to all railroads, where loaded cars may be gathered from all points of origin within the city, and may then be assembled in trains, according to destination.

These three fundamental requirements, while thus susceptible of simple statement, involve innumerable complex problems.

"NEW YORK is unique among the great cities of the world in the character of its harbor and the extent of its riparian lines. The great extent of its deep waterways, however, while giving it unrivalled accessibility for water-borne cargoes, creates difficulties greater than in any other case, in the handling of cargoes intended for interior distribution by rail. Only one trunk line of rail available for freight enters Manhattan. Over all other west-bound lines freight must enter and leave New York by water carriage, usually by cars on floats."

THE EMANCIPATION OF NEW YORK COMMERCE

"On the solution of these problems depends the emancipation of New York from the bonds which now hamper its commerce and its restoration to its former position of not only the greatest, but the most convenient and economical seaport of the United States. The fact that the city authorities are now keenly alive to the situation, and that they are now working in cordial co-operation with the great commercial organizations which represent the commercial and industrial interests of the city, gives assurance that the problems will be solved; that plans will be developed which will meet all of the necessities of the situation, and that means will be found whereby these plans can successfully be carried to completion.

"New York is awake to these problems, and there is no doubt but what provisions will be made for both the near and the distant future, and that, too, in a most efficient way.

EMERSON E. PARVIN, SECRETARY OF THE INTERNATIONAL MERCANTILE MARINE COMPANY

Mr. Emerson E. Parvin, secretary of the International Mercantile Marine Company, says:

"Speaking of the principal Atlantic ports which are the gateways for an enormous traffic which is constantly increasing in volume, the dock facilities have not kept pace with the requirements of this great commerce.

IMPROVEMENT FOLLOWS URGENT NEED

"As a general statement, it may be said that improvement in the facilities for handling the commerce of a port comes only after the need for it becomes most urgent. In these days, when there are two immediate uses for every available dollar, the request for the capital required for investment by a city or state in additions and improvements to its port facilities is not always placed at the head of the list. The traffic grows; it cannot be handled economically; the shipper protests; the consignee threatens;

the consumer complains; pressure is brought to bear by all these influences on the administration, and the situation is met, only to arise again with the increasing prosperity of the country.

"Congress has been keenly alive to the advantages of wide and deep channels, and millions have been appropriated to make safe and commodious approaches to the principal harbors on the Atlantic Coast for steamers of large dimensions; but these great improvements fail to realize their full value if adequate pier facilities are not provided within the harbor for the large steamers which have come into existence as a result of a legitimate demand for them.

A SEAPORT HAS VALUE IN DIRECT PROPORTION TO ITS RAILROAD CONNECTIONS

"In many of the Atlantic ports we are behind in developing our natural advantages, with the possible exception of Philadelphia, which, however, is ninety miles from the sea.

"A seaport has value in direct proportion to its railroad connections, for the railroads, next to the farmers, are the greatest force contributing to our commercial prosperity.

"The railroads are usually quite willing to take advantage of natural resources, but they cannot depend entirely upon domestic output and consumption to furnish the tonnage required to justify the construction of, say, a trunk line.

"The States and Cities are generally desirous of doing everything possible to first attract, and then keep, commerce with other States and foreign countries. To accomplish this it is absolutely necessary to have proper channels and adequate port facilities for that part of the transportation which is done by water.

"Congress appropriates money for the deepening and up-keep of the channels and rivers; the War Department has jurisdiction over the waterways of the country; and it therefore becomes necessary for the civic authorities to get the permission of the War Department before any contemplated improvement which includes the extension of pier-head lines can be undertaken. Sometimes this is a very difficult task; but in the end it will be appreciated that to spend millions on the approach to a harbor, and then deny the right to a city to build proper piers for the large steamers that seek to do business with the port, is somewhat inconsistent.

Baltimore Docks.

"The solution of this question is to sustain, encourage and develop the commerce of the port through the intelligent co-operation of the citizens, merchants, commercial exchanges and trade bodies; then to see that the facilities of the port are maintained for the present, and planned for the future tonnage, which seeks terminal accommodation within the harbor.

MASSACHUSETTS AFFORDS AN EXAMPLE

"An example of what can be done is afforded by the action of the State of

Massachusetts. A committee called 'The Directors of the Port of Boston,' has been appointed and a very large sum of money was appropriated by the last Legislature to be expended under the authority and direction of these directors for improvements in terminals, piers, etc., deepening of channels, and the general care of the port.

FROM THE PRESIDENT OF A SUCCESSFUL TERMINAL COMPANY

Irving P. Bush, President of the Bush Terminal Company, New York, says:

"Many conditions combine at the present time to direct attention to the necessity of improving and developing the facilities of the harbors in different parts of the United States.

PUBLIC CREDIT FOR HARBOR DEVELOPMENT

Probably the nearing completion of the Panama Canal has done more to center attention upon this subject than any other one thing. Various ports are using public credit for the purpose of developing facilities which will attract ocean-borne commerce. The State of Massachusetts has appropriated $10,000,000 to improve Boston harbor. New Orleans already owns a large part of its wharves and controls its marginal railroad. Baltimore has spent a considerable sum upon dock construction. Los Angeles has appropriated $10,000,000 to develop a harbor, and Seattle has begun the expenditure of $8,000,000 to extend its port facilities.

THE EXCUSE AND UNDERLYING REASON FOR INTEREST IN PORT FACILITIES

"While the preparation for the Panama Canal trade has been the excuse for this widespread interest in port facilities, the underlying reason is probably a recognition that we are just entering the export stage of our national development. It is impossible to lay down any set rules which must be followed, but, as New York has made more history in commercial development than any other center, its experience and mistakes should be taken advantage of by other cities entering upon a harbor development programme. Other ports will not enjoy the great natural advantages which have been of such great assistance in developing the commerce of New York. Most of them must, in the beginning at least, enter into competition with other ports for ocean commerce.

ONE FUNDAMENTAL MISTAKE

"One fundamental mistake seems to have been made by the city authorities in spending public money in port development at New York.

TOO LARGE EXPENDITURE FOR FACILITIES FOR PASSENGER LINES

"The mistake has been in spending too large a proportion of the funds available in providing facilities for passenger steamship lines and doing little or nothing for the accommodation of freight lines. This is probably due to the spectacular features attending the docking of a great passenger steamer which centers this class of commerce in the public eye.

THE INDUSTRIAL CORNERSTONE OF A COMMUNITY

"In considering what course should be adopted for the development of a port, it seems to be fundamental to recognize that the freight carrier, both on land and sea, forms the industrial cornerstone of a community. The freight carrier brings merchandise to be manufactured, financed, insured, warehoused and handled in numberless ways.

ENCOURAGED THE CLASS OF COMMERCE THAT DEVELOPS INDUSTRIES

"The passenger trade follows industrial conditions which have been created by the freight carrier. Any community, therefore, in undertaking to carry out a harbor-development plan will do well to direct its first attention to the encouragement of a class of commerce which will develop its industries."

THE VIEWPOINT OF A NEW YORK REAL ESTATE MAN

Charles E. Heitman, General Manager of the Debenture Corporation of New York.

IN NO SENSE A LOCAL QUESTION

"It must be remembered that while New York City, geographically and po-

litically belongs to America, commercially it belongs to the world. Therefore, the transportation facilities of New York become a matter of international interest. And in considering the urgent need of water-front betterments, we must recognize that the world has a right to expect and demand accommodations exactly in proportion to our commercial importance.

"With many miles of water-front at our command, it is ridiculous for us to be placed in a position where we cannot accommodate the largest ships afloat. It would seem entirely practical to have our international traffic classified, as it were, so that a part of it could be diverted to the Long Island Sound; in other words, open up the several doors that lead to Greater New York, rather than try to bring all the traffic through one door.

"While the Government of New York City should be held to strict account for proper action in this matter, yet we do not want to lose sight of the fact that this is not exclusively a city problem, but one that should, and does, necessarily involve the nation, for the reason that every State in the Union, from a commercial standpoint, is to some extent interested in and dependent upon the waterways of Greater New York, and, in a similar fashion, are the nations of the world interested.

FEDERAL AND CITY GOVERNMENT MUST GET TOGETHER

"Unless the Federal and City Government at once get together and decide upon a definite plan of operation, they will not only be neglecting a serious duty they owe to American business interests, but they will be laying themselves open to just criticism from all sections of the globe."

FROM A LEADING BANKER AND IMPORTER

Cesare Conti, Banker, Importer and Important Official, of the Lloyd Sabaudo Steamship Line, New York.

TOO MUCH CANNOT BE DONE TO PERFECT DOCKING FACILITIES

"The harbor of New York City is sheltered from all the storms of the high sea, and the streets of our great metropolis come right down to the waterfront. It is not sufficient, however, that we have been blessed with the greatest natural water gateway in the world. Where nature has left off art should begin. We cannot, while the rest of the world is advancing in all directions, sit still. Too much cannot be done in the way of perfecting the docking facilities of the greatest port in the United States. Here the greyhounds of the sea join by geographical affinity with the transportation arteries of our glorious land—the railroads.

$10,000 RECEIVED FROM EACH TRANSATLANTIC LINER THAT PASSES THE STATUE OF LIBERTY

"The railroads have to depend on the steamship lines for their outgoing and ingoing freight, to say nothing of the many passengers they are always carrying into and out of New York City to and from the steamship wharves. Why should any reactionary policy in this very important matter even be considered? If we hug any obsolete prejudice, we do so at the cost of the best interest of the whole nation. Many European tourists who could as well go to South America or Australia are drawn to the United States because of the swift, luxurious steamships that land in New York City. The merchants and hotels of the whole United States benefit by this. Every time a trans-Atlantic liner passes the Statue of Liberty it means a revenue for this port of about $10,000. This is for pilotage, docking, coaling, unloading and loading, etc., and, in addition, Uncle Sam collects a head tax revenue of $4 on every imported American that comes to our friendly shores.

EXTENDING THE DOCKS SHOREWARD INTO THE LAND WOULD INCREASE THE VALUE OF THE LAND A THOUSAND-FOLD

"To separate or to interfere in any way with the present conjoining of ocean steamships and land steam trains would be like cutting a nerve. One of the ways to meet conditions that are arising is to cut docks right into the land—for one-hundred feet, say—on either or both sides of the lower Hudson. This displacement of the land would increase the

value of the land, paradoxical as it sounds, one thousand-fold, and would occasion loss to nobody. Besides, the objections made by the Secretary of War, Stimson, with reference to the channel ways of the river, would be overcome. I am in favor of Congressman Sulzer's bill to advance the established pier head line on the lower Hudson River uptown about a mile and a half.

"In my opinion three or four days in delivery could be saved if Jersey City were made a port of entry, and, in addition, this would give Jersey City a maritime prominence which it deserves. Newark is now a port of entry, and yet no trans-Atlantic steamer can dock there; and the fact in itself that there are but two customs brokers in that city shows how unimportant it is as a port of entry. On the other hand, look at the magnificent waterfront of the Jersey coast with its docking facilities. The North German Lloyd, Hamburg-American, the Holland-American, the Scandinavian-American all dock on the Jersey side of the Hudson River."

NEW ITALIAN STEAMSHIP LINE TO WEST COAST OF SOUTH AMERICA VIA THE PANAMA CANAL

"I fear that New York City will indirectly be the loser by the new sea route that will be opened up when the Panama Canal is completed. The tolls will not bother foreign shippers, who are very much alive to the advantages to be derived from the 'big ditch.' This is realized by the fact that a six-million-dollar corporation—*Societa di Navigazione Maritima Italiana*—has recently been chartered to build and operate a line of passenger and freight steamships between New York and Italy and the west coast of South America via the Panama Canal."

W. Van Doorn, Manager Holland-American Line.

GOVERNMENT ENDEAVORS TO ACCOMMODATE SHIPPING

"Very many improvements, especially in the ports of New York, Philadelphia, Boston, Baltimore, etc., show that this Government certainly tries to accommodate shipping to the best of its ability, and the enormous amounts involved in making alterations are greatly responsible for unavoidable delays in the execution of same.

"Increased efficiency may be obtained by the building of new long piers, with sufficient depth to accommodate the recently-built large steamers.

"The Holland-American Line started the trans-Atlantic service in 1873 with the S.S. *Rotterdam,* length 242 feet. In 1900 the fleet was practically reorganized with steamers of the type of the *Ryndam, Noordam* and *Potsdam,* of 586 feet in length. Thereupon the S.S. *New Amsterdam,* with a length of 615 feet, was built in 1905, and the S.S. *Rotterdam,* with a length of 677 feet, was brought into service in 1908; whereas a triple-screw turbine steamer is now in course of construction of about 820 feet in length. The present fleet consists of five passenger and twelve modern freight steamers.

LONGER PIERS A NECESSITY

"The increased length of the modern steamers makes it absolutely necessary to extend the length of the present piers, as it is self-understood that no owner is willing to take the responsibility of having the steamer project beyond the end of the pier, and consequently, leave part of the ship unprotected, which is absolutely unsafe and inadequate."

THE PORT OF PHILADELPHIA

George W. Norris, Director Department of Wharves, Docks and Ferries of Philadelphia.

"To the question: 'Is the commerce of America growing too large for our facilities, or are our people behind in their development of the same,' assuming that by 'our facilities' is meant our natural facilities—deep water harbors and rivers by which commerce can be brought to the point of exchange between water and land carriers—I would answer emphatically, no!

SUFFICIENT NATURAL, BUT INSUFFICIENT ARTIFICIAL FACILITIES

"We have a sufficient number of ports, harbors and inland rivers to handle not only the present bulk of commerce, but also as much as it is ever likely to be-

come; but we have failed to provide the necessary artificial devices and facilities —such as sufficient depth of channels, a requisite number of piers and warehouses, proper terminal facilities within the ports whereby cargoes may be transferred from ship to railroad train or storehouses, or vice versa, with the greatest saving in time, money and labor.

"The port problem today, as I view it, is not that the commerce is too large, but that the artificial facilities for handling it are entirely inadequate, and that there is a lack of proper co-ordination between land and water carriers, piers and warehouses; to which is due the loss of economy and, therefore, a stunted commercial growth. Happily, this question of proper co-ordination and increased efficiency is occupying the attention of virtually every port authority in this country today, and promise of early improvement, and eventually the entire elimination of this difficulty, is had through application of the principles of public ownership and administration of port terminal facilities, which has proved successful wherever it has been tried.

CORPORATE MONOPOLY AND LACK OF PUBLIC INITIATIVE

"Corporate monopoly on the one hand and the lack of public initiative or interest on the other, were the prevailing conditions in most of our ports until quite recently, and they continue to exist in a few, thus preventing the necessary development. Perhaps this may be explained by the fact that individually and as a nation the attention of the American people, until a few years ago, was directed almost entirely toward opening up our great natural resources, and in the many manufacturing pursuits which for so long made commerce within our own borders sufficient. It was during that period that corporate interests gained control of valuable waterfronts. What should have been public utilities became the weapons of monopoly, and commerce suffered the result. Public ownership has proved to be the remedy, and is in itself evidence of an awakened public conscience and a general realization of the importance and need of adequate port facilities.

ELIMINATING PRESENT DELAYS

"Essentially, a port is the point of exchange, where shipments must necessarily be transferred from water carrier to land carrier; and it is that principle, with all the improvements and reforms it entails, that I am aiming to attain for the port of Philadelphia. The too prevalent tendency of making a storehouse out of a pier is a hindrance to commerce which can best be measured by the hundreds of thousands of dollars lost annually by shipping companies while their vessels are lying partially idle in port waiting to load or discharge cargo with the prevailing inadequate facilities. The third necessity is a co-ordination between railroads and vessels which will provide for the immediate removal from the ship or pier of all cargoes destined for the interior, and by the same principle will eliminate present delays in getting the products or commodities of the hinterland to the ship which is to carry the cargo to foreign markets.

"It is my idea that all of these purposes are best served by having a sufficient number of piers to accommodate all the possible commerce, import and export that could be brought to a port; by having each of these piers of sufficient size to carry inbound and outbound railroad tracks, with sufficient additional space for drayage, and every pier equipped with the necessary mechanical appliances to load or unload a vessel on either side in the shortest possible time.

PROCURING THE FULL EFFICIENCY OF A PIER

"Procuring the full efficiency of a pier depends, of course, upon getting a maximum use from it, and to this end warehouses should be operated as adjuncts to, but not as a part of, the pier itself. There are exceptions to such a rule in the case of piers designed to receive special cargoes, in which case it may be advisable to devote upper portions to storage purposes; but even then the business should be so regulated as to eliminate any delay in receiving additional cargoes.

WHAT NEW ORLEANS HAS ACCOMPLISHED

Tiley S. McChesney, Assistant Secretary and Treasurer of the Board of Port Commissioners of New Orleans.

"WORLD'S FINEST EXAMPLE OF PORT ADMINISTRATION"

"The port of New Orleans is, perhaps, the finest example of port administration in the world; I have been so favorably impressed with the conception, administration, operation and success of the New Orleans harbor scheme that I am at a loss how to adequately describe the situation."

"The Board has had control for practically eleven years, for, though the Board assumed its duties in 1896, it did not take control until 1901, when the lease of the Louisiana Construction and Improvement Company expired. Since then the wharf system has been entirely rebuilt and largely extended. The Board controls twenty-two and a half miles on the west bank, and seventeen miles on the city side, and on this side alone there are six miles of wharf either built or nearing completion.

"There is an outstanding bond issue of $3,500,000, the proceeds of which have been used for the improvements; and as the revenues derived from the operation of the utilities pay the running expenses, maintenance, insurance, interest, and create a sinking fund, the improvements have not cost the citizens of New Orleans one cent. In 1901 52 per cent. of the total tonnage berthed at the public wharves; while 1911 showed 83 per cent.

"New Orleans is the cheapest port in the South, and one of the cheapest in the country. Port charges were fixed in the acts creating the Board, and will be decreased when all improvements have been made to a bare maintenance basis. The policy of the Commissioner is to own and direct the operation of the entire water front. No leases of wharves or sheds are granted, but for the convenience of shippers and transportation companies, assignments are made to regular lines by resolution of the Board. All vessels, whether regular liners having assignments, or tramps, pay identically the same charges, and are given equal opportunity to transact business in the port. Dock and shed charges are made against the ship, and very light harbor dues; there is no wharfage on goods or passengers."

Great car floats used for transferring merchandise in New York. A unique method for handling freight upon the waterfront. The proper use of New York's unequalled facilities in this respect forms an important and urgent problem.

A FIVE-STORIED STREET

AN EFFECTIVE AND PRACTICAL PLAN FOR HANDLING THE CONGESTED TRAFFIC IN GREAT CITIES

BY HENRY HARRISON SUPLEE

DURING the past few years the question of handling the human traffic in the business sections of the great cities of the world has reached what may properly be termed an acute stage, and at the present time there appears to be no definite systematic attempt to solve the question.

Like most questions, it has many sides, and contains within itself a number of conflicting elements, and in most cases the attempts to effect its solution emanate from interested elements desirous of settling it to the advantage of some especial party. The matter was difficult enough when the transport of passengers was wholly in the hands of corporations operating street cars, omnibuses and other public vehicles; but of late it has been extended to include, not only underground systems of local transport and tunnels forming portions of main-line railway systems, but also independent motor cars, operated either by their owners or by more or less irresponsible chauffeurs. Under such circumstances it is hardly a matter for surprise that rules and regulations formulated for wholly different conditions should fail to meet the situation.

In many quarters, even where a more intelligent view of the situation might have been expected, the result is a denunciation of modern power vehicles, and the electric car and the automobile come in for violent attacks and attempts at so-called regulation, as if it were either desirable or possible to restrict or impede the progress of the very means by which the problems of transport may be solved. A more rational manner of considering the question might well be to prepare for changes which a mature study of the subject would indicate as both inevitable and desirable, having in mind a realization that the old order is changing and that any efforts to arrest progress are futile; while, at the same time, the future carries with it a promise of improvement only waiting to be grasped by those who are progressive enough to perceive it.

The older roads and pavements were designed for horse traffic and for the wearing effects of heavily loaded vehicles with comparatively narrow tires, hauled along by a pull upon the body of the vehicle, transmitted to the road as an inclined push through the legs and hoofs of the animals. In many of the older cities of Europe and Asia there was no distinction made between the man on horseback, the heavily loaded cart and the pedestrian all painfully toiling along upon the same cramped and narrow street, or traversing the main road. The great Roman roads were primarily designed for military purposes, and although based upon massive foundations of masonry, their principal object was to enable large bodies of infantry to be thrown rapidly upon any of the provinces of the empire which might become unruly or insubordinate.

The question of vehicular traffic is easily taken care of, so far as the highway for the motor car itself is concerned. The real difficulty lies, not with the provision in cities of a highway for the car, but with the maintenance of a clear roadway, so that the full advantages of the speed of the motor car may be realized without danger to the foot-passer. The experience of the past few years has demonstrated that there is but one way in which this can be effected, and

that is by the entire segregation of pedestrian and vehicular traffic.

Under the law, the sidewalks and crossings belong to the pedestrian, the former at all times, the latter, so far as precedence over passing vehicles is concerned, subject to the local traffic regulations. If the foot-passer dodges across the street at other points than the regular crossing he does so at his own risk, and it is certainly true that many accidents are due to this cause. The difficulty of keeping the regular crossings clear in the more crowded streets, however, emphasizes the necessity for a provision enabling the original idea of the separation of foot and vehicular traffic to be maintained in the face of the new conditions.

Such a provision, fortunately, is both evident and simple, and, besides solving the question of the segregation of foot and vehicular traffic, it also goes far toward the solution of the problem of the relief of general congestion. This plan is simply that of constructing elevated sidewalks, to which all pedestrian travel should be directed, leaving the surface of the streets solely for vehicles of all kinds.

This method is by no means a new one; on the contrary, it is very old, much older than the earliest date assigned to any motor vehicle and older than any crowded modern city. The "rows" of Chester remain as relics from mediæval times to show that elevated sidewalks are no novelty. The waterfronts of many seaports show piers and platforms by means of which pedestrians walk in freedom and safety above the press of teams and other vehicles. A number of years ago the late Sir Frederick Bramwell proposed such elevated sidewalks in connection with the proposition to construct a new street between Holborn and the Strand, and although this plan was not carried out, that eminent engineer evidently foresaw how effectively this method would solve the problem of the segregation of foot from vehicular traffic. In a number of the seashore resorts in the United States, Atlantic City being a notable example, the so-called "board walks" testify to the manner in which such elevated sidewalks are appreciated by the public and form ample demonstrations as to the feasibility of the system.

The advantages of such a system of elevated sidewalks are so numerous that one scarcely knows where to begin in their enumeration.

In the first place, they should be constructed at the level of the first floor, or on the second-story level, as it is called in the United States. This at once gives ample height to cross all streets with sufficient headway clearance for vehicles passing beneath, and also provides all the buildings with a second set of entrances.

This latter feature should certainly appeal to occupants of stores and business buildings when it is seen how eagerly the owners of shops facing stations of the elevated railroad in New York have grasped the privilege of building connecting bridges from their upper floors to the station platforms.

We thus have at one stroke lifted the foot-passer to a level of safety, doubled the traffic capacity of the street and greatly increased the commercial value of the abutting property.

Not only is the entire upper floor of every building made available for show-windows and the retail business, but the street level is cleared for delivery teams and wagons and opened to permit motor vehicles and their owners to approach freely.

With such a relief to the street level all speed restrictions might safely be removed, and the passing throng above could gaze with interest upon the speeding vehicles below, free from the honking terrors of the present unbearable conditions.

In cities such as New York and Chicago, in which conditions have practically compelled the erection of tall buildings to meet the demand for space in the commercial districts, it is well understood that much of the congestion, at certain hours of the day, is due to the general movement of the occupants, and this difficulty is one which is becoming aggravated with the increased construction of skyscrapers within a limited area.

The City Street of the Future.

Danger to human life eliminated and speed efficiency of business traffic increased twenty-five per cent.

In such portions of a city the applicability of the elevated sidewalk becomes capable of further extension. If the building regulations included one or two upper levels of coincident heights in all buildings, a restriction no more onerous than the limitation to a certain front building line, it would be practicable to extend bridges from building to building at such levels and permit a general distribution of much of the crowd before descent to the street level became necessary. The space which such passageways would require within the buildings themselves would be more than repaid by the desirability which such access would give to the upper floors, and such a plan would go far to relieve the local crowding of the elevators and possibly render practicable a rearrangement of elevator service in many such buildings.

It has long been understood by engineers who have studied the difficulties of transport in cities that high actual running speed is less essential to rapid transit than is freedom from interruption. If continuity can be maintained, it is manifest that a much lower running speed becomes necessary for a given transport capacity than when many stops have to be made. Furthermore, much congestion is due to the concentration of people at certain points in a transport system, as compared with the distributing effect of a system which can be boarded anywhere. These considerations have led, in various instances, to the idea that some such continuous system of transport as is furnished by the traveling platform would afford much relief.

It is probable, therefore, that if the plan of the elevated sidewalk is introduced, to relieve the congestion which is continually increasing in our great cities, it may be followed by the installation of some such type of continuous transport on one of the upper levels. When it is considered that such a system would distribute along the entire length of the structure the people ordinarily crowded into detached trains, and that all local concentration at stations would be replaced by a continuous transfer of passengers to and from the traveling road, the extent of the relief which would follow may be gathered.

Considering the problem of municipal congestion, therefore, from the viewpoint of the scientific engineer having before him the definite task of allaying the evils of excessive concentration, it seems as if certain fundamental principles appear to guide in its solution.

Broadly, the idea of decentralization, as opposed to concentration, should govern all plans for additional transport facilities. While such a principle will doubtless meet with disapproval at first from interests situated at existing centres of congestion, it must naturally make for a far wider development of the larger area and become a controllable source of healthy and exceedingly valuable growth for the entire community.

To this idea of decentralization should be added a full appreciation of the advantages of segregation of pedestrian and vehicular traffic, both for reasons of comfort and safety, and because such a segregation is essential to enable the full advantages of both classes of traffic to be secured, removing speed limitations to vehicles and permitting absence of interruptions of pedestrians.

In addition, the immense increase in capacity in any movement attained by maintaining the principle of continuity, as opposed to that of periodical interruptions, is included, since it enables much of the increased capacity to be obtained without corresponding increase in actual velocity.

All plans for intelligent reduction of congestion, while at the same time providing for ample future growth and development, necessarily include the study of each problem upon its own merits by competent engineering specialists, provided with full powers to devise and execute the most effective methods, independently of pressure from local interests and unhampered by political considerations.

The problem is an engineering one, and it should be planned and executed as such, as fully as if it were the construction of the Panama Canal or the completion of the Catskill aqueduct.

WHY NOT CHANNEL TROLLEYS?

DOING AWAY WITH PILOTS AND LESSENING FOG DANGERS

This interesting subject is described by the inventor of the supposed system, Mr. F. W. Fitzpatrick, of Washington, D. C., and the increasing problems of Channel Navigation make the subject a live one, and Mr. Fitzpatrick's invention one worthy of careful consideration.

FOR the purpose of insuring the safe pilotage of incoming and outgoing vessels in foggy weather, an interesting new scheme has been devised. Anyone who has stood on the deck of an incoming ship during foggy weather and observed the anxious face of his captain, the repeated heaving of the lead, the careful feeling of the way, the snail's pace the ship is making and a thousand other indications that that ship is in dangerous water and her navigators fully realize it, must perceive that such navigation is extra hazardous and absolutely dependent upon the most primitive methods for its direction.

Ocean Liner guided through a difficult channel by proposed trolley system.

A heavy fog not only prevents one from seeing, but is a distorter of sound as well. One hears the blast of a siren or the ringing of bells, but he can not safely judge of their distance. In most cases fog horns mark dangerous points and a navigator has to guess not only where that fog horn is but just how far he has to keep away from it to avoid the danger of which it warns him. So with ships. Often in yachting I have heard a warning whistle and imagined a ship well to port or to starboard and some distance off, only to have my hair raised a moment later by seeing a great black hull looming up perilously near and on the other side from which I first thought it to be.

Various schemes have been thought of and some installed to achieve safe navigation in a fog, such as a continuous line of buoys, electric indicators and channel finders. Most of them are impracticable, and some have been positive obstructions to navigation in fair as well as in foul weather.

The trolley car suggested this idea. The conditions are somewhat reversed, but there is a resemblance. Since I first suggested it others have worked along the same lines and at one time got the shipping interests pretty well enthused over an actual sea trolley line. They wanted to use my scheme of trolleys on a submerged cable but were going farther and proposed electrifying that cable and letting the ships go in and out of port via this electric power. They even got so far as to frame a bill to put into Congress, but then the scheme died out and I believe it utterly impracticable and not at all useful, excepting that part of it I had already devised, the indicating of the channel. But what is the use of supplying power to navigate a ship that has plenty of power of its own and to supply a power to it that would cost enormously more than its own? Carrying an electric trolley under water and connecting with it means more than just loss of electricity.

The scheme here described has been thought out more particularly for New

York's harbor, but it is applicable to the San Francisco ferry lines, or any port where the depths are not prohibitory. In the New York harbor I would lay a heavy wire cable from a point near the Battery, through the channel, the Narrows, and preferably the outer east channel, to a point between the Scotland and the Sandy Hook lightships. At that point is safe water, 60 feet deep and more.

This cable I would continue back, at a safe distance from the other course, a half mile or so, to the point of departure, and there splice the ends. Then we would have a continuous cable, a loop, anchored at suitable distances, so that it might not be tugged out of place and become a source of danger.

The two lightships mark deep water. Along the line I have described there is from thirty to sixty feet of water, in some parts a dredged channel. No part of this course offers any considerable difficulty to divers in inspecting and repairing such a cable.

At the sea end of this loop there would be maintained another lightship, or one of the existing ones shifted to that point. She would be armed with the most powerful fog horns, bells and guns, or whatever scientists prescribe as the best noise in a fog. It would not be a warning of danger, but a call to safety, and every incoming vessel would steer for it.

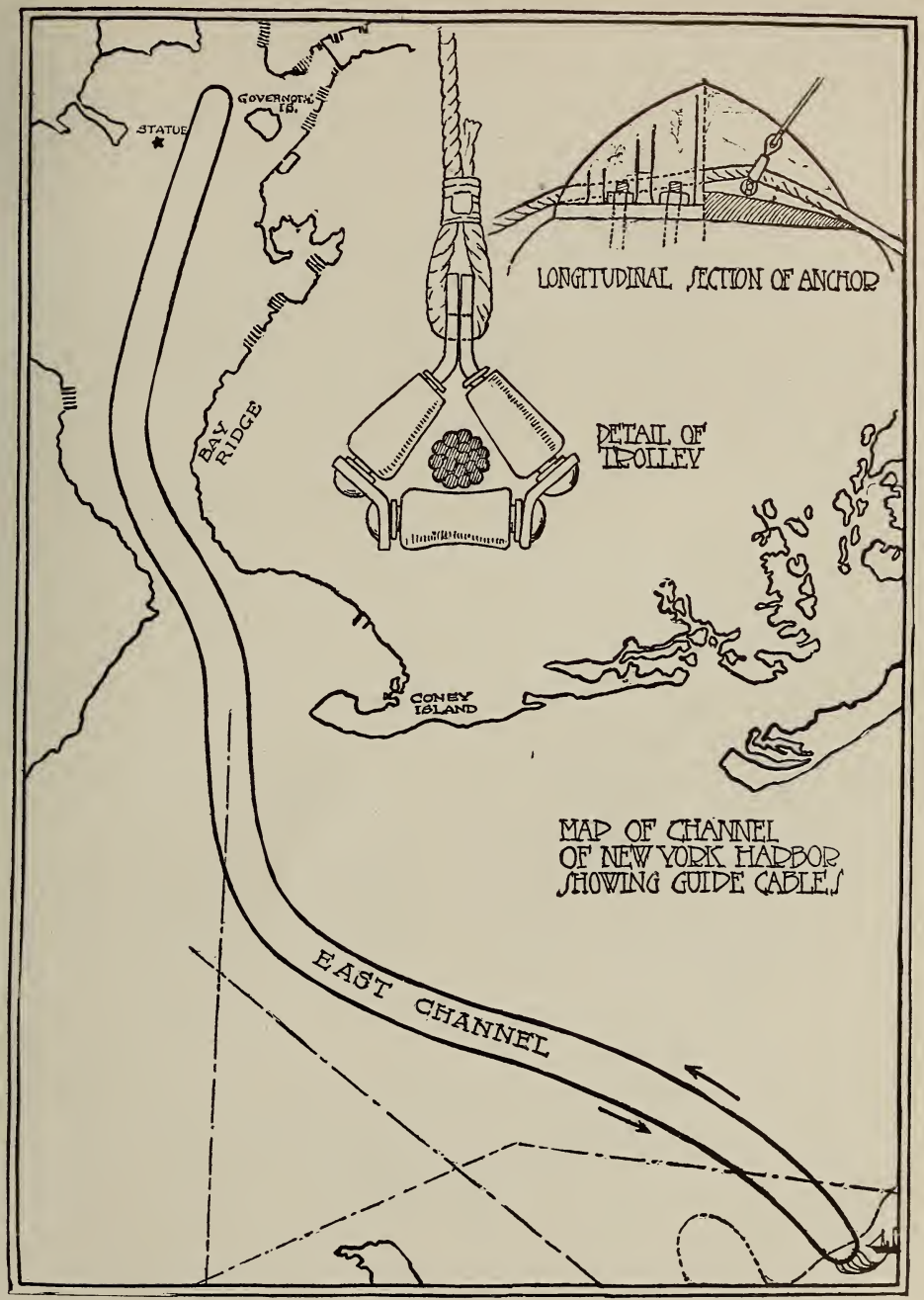
On this cable would be a number of specially devised rings, to which other and lighter lines would be attached. These lines or trolleys would be buoyed at a length to insure floating in maximum water, say 125 feet, so as to be marked in case of loss or break. There would be a sufficient length of cable or trolley line to cover the angle of drag and varying depths and for handling, slack, etc.; in all, say 600 to 700 feet of line. All these lines, from a sufficient number of rings, would be held on this "safety," or lightship, and a similar number of them held on a tug or other boat at the shore end of the loop.

In foggy or thick weather, or when indications would point to the probability of such weather—or, for that matter, at all times—there should be a harbor regulation prohibiting all sailing craft from entering or anchoring inside of this 60-foot depth, unless in tow of a tug or steamer; and another regulation compelling all such tugs, boats and steamers whatsoever or by whosoever piloted to steer direct to this lightship and there receive one of these trolleys. In calm weather it could be handed over by a lighter "casting line," such as is used in handling heavy landing or tow lines, and in rough weather it might be shot across a vessel's bow. But there is seldom any sea on in a fog; a heavy sea means wind, and wind means no fog.

This trolley would be taken on astern and the vessel would then proceed under its own steam at a safe and prescribed rate, dragging its trolley along the main cable. As long as the pull is fair astern, the ship is on its right course. Naturally, the mariner would have to calculate for drift, currents and the angle of descent his trolley line indicates, but it would be a thousand times safer calculation and easier than the constant sounding and the calculation he has to do now. There would be the assurance that he was safe, that no one could run into him if he kept to the rate given him. He would have to watch that rate most carefully so that he would not run into the fellow ahead of him, and he would have to make noise enough to insure the ship following him from colliding with him from behind. For all the world it would be the same as navigating a cable car, minus the inherent dangers of the cable and the passing of teams and people.

The amount of line he would have to pay out would indicate the depth of channel the pilot was in and would tell him positively where he was. The pilot, in other words, would direct from the stern instead of from the bridge.

Each vessel should have an automatic steam drum adjusted to the drag or pull of the ring along the main cable, virtually lifting that cable a trifle, but not enough to drag it or raise it more than would allow the passing of that ring under its under surface. It should be so adjusted, too, that the angle would be maintained, paying out and taking in



New York Harbor Made Safe.
Chart shows suggested plan for guide cable system.

according to the varying depth, but shutting off steam at the maximum depth and then loosely paying out the slack line until the vessel could be stopped and the trouble investigated. If the line were made fast to the vessel any catch or accident would mean the breaking of the trolley line or damage to the main cable or its anchors.

All incoming vessels would follow along the right cable and deliver over their trolleys to the tug or other boat charged with the mission of receiving them at the shore end of the loop. Outgoing vessels would receive the trolleys from this tug and also follow along the right of the loop, handing over their trolleys to the lightship at its outer end —a system of double-track street cars, pure and simple.

The trolley would be a guide, friend and compass, a sounding line, a guaranty of safety to the holder and to all other craft. The anchorage of the cable would be such that the pull, being upward and the trolley ring being provided with rollers, it would be bound to pass through the opening left for it in the anchors.

The cost of laying forty miles of such a cable and anchoring it at every half or quarter mile would be insignificant when compared with the cost of collisions that so often occur, the delays, the lengthened scheduled time that has to be counted upon, the cost of pilotage and towing; not to speak of the imminent dangers and the other disadvantages of our present antiquated way of getting into and out of New York and other ports.

If a copper cable would cost too much, why not use a steel wire, one of large members, protected or coated to last as long as possible? They say it would rust out in four or five years; then repair it or renew it. It will have paid for itself a hundred times over.

So with the anchors and trolleys. Salt water, slime, and rock bottom, all will affect them; nothing is absolutely permanent. There must be provision made for repairs and maintenance. If Congress will not appropriate for it, then the shipping companies can well afford to do it themselves.

The rules and regulations, the forbidding of casting anchor near this cable to avoid dragging or breaking it, the keeping out of sailing vessels, etc., the protection of this cable as that of lightships, buoys, channels and other harbor improvements are matters for the authorities to devise and enforce. In all radical innovations or departures from long-established customs there is a mass of such matter to be gone into, but that such details present difficulties and serious ones is no sign, nor does it necessarily follow that the scheme itself is defective.

I claim that it would be equally applicable to any port, to ferry lines or to any navigable course, provided that the depths be not prohibitory.

HYDRAULIC POWER DEVELOPMENTS IN THE SOUTH

HOW FLOOD WATERS ARE BEING CONTROLLED AND UTILIZED

IN the discussion of the conservation of natural resources it is important to distinguish between those which are consumed once for all, such as coal, timber, etc., and those which, under all present conditions may be expected to continue, such as the power of falling water, the heat of the sun, the movement of the tides and of the waves, and the like.

The power capable of being developed from falling water is a resource which is being developed to great advantage in many localities, and among these the southern states possess noteworthy opportunities.

Thus, for example, South Carolina, while one of the smaller states of the Union, possesses, apart from her agricultural resources, the advantage of such a topographical situation that the flow of water from the mountains to the sea renders it possible to develop a great amount of power independently of the combustion of coal, a resource which she wholly lacks. Ten years ago not more than 27,000 horse power represented the hydraulic power of South Carolina. To-day nearly ten times that amount is utilized. The estimates of the United States Geological Survey supported by other conservative figures, show that from 800,000 to 1,000,000 horse power are capable of profitable development in the state.

In general, the Southern Appalachian district, including, as it does, the flow of the streams from the mountains to the sea over a rapid and considerable fall, has rendered possible the development of a number of important hydraulic-power plants, and will undoubtedly include a continual development of such sources of power in the immediate future.

Not only the Carolinas, but Tennessee and Georgia, offer remarkable opportunities for the development of hydraulic power, opportunities which are already being utilized in some degree and which will doubtless be still further developed.

Apart from the small and individual power plants in these states, mention must be made of the installations of the Southern Power Company, these including stations at Catawba, Great Falls, and Rocky Creek, on the Catawba river; at Ninety-Nine Islands, on the Broad river; and at Greenville, on the Saluda river, these aggregating more than 100,000 horse power, distributed over the cotton-manufacturing district by a high-tension, three-wire transmission system, and operating more than 2,000,000 spindles, and 43,000 looms, formerly driven by steam power.

Another hydro-electric power system in South Carolina is that at Parr Shoals, on the Broad river, where J. G. White & Company has under construction a concrete dam 35 feet in height and 2,200 feet long, rendering available about 200,000 horse power. This will be divided into eight units, of which five are to be installed immediately, leaving three for future installation as the demand for power may warrant. Since this station is only 28 miles from Columbia, the opportunities for the ultization of the electrical energy are abundant.

At Stevens Creek, near Augusta, Georgia, the Augusta Power Company is developing a power plant which is expected to yield about 20,000 horse-

The Great Dam on the Ocoee River at Parksville, Tennessee

The construction work is shown as it existed seven months after commencement. The concrete dam is partially completed, and the power house appears on the left. When the dam was completed the valley above formed the storage reservoir for power supply and stream control. Messrs. J. G. White & Co., Builders; Eastern Tennessee Power Company, Owners

power, and the works there are also being built by J. G. White & Co. This construction is of double value in that it will aid in controlling the water which formerly did much damage to the city of Augusta, besides converting its energy to useful service.

The Eastern Tennessee Power Company has recently had completed by J. G. White & Company, a remarkable hydro-electric power plant on the Ocoee river, at Parksville, Tennessee. This plant, utilizing the run-off from an area of about 600 square miles, is situated at a point where the Ocoee river passes through a narrow gorge; a dam 125 feet high and 840 feet long, creating a storage lake of 3½ square miles in area, and rendering available about 38,000 horse power. Additional power development on the Ocoee river will enable this to be brought up to about 75,000 horse power, available for distribution to Cleveland, Chattanooga, and Knoxville, in Tennessee, and to Rome, Georgia.

The especial advantages of this region of the United States for the development and utilization of water lie in the constancy of the supply as well as in its volume. In western North Carolina the mean annual precipitation is from 60 to 70 inches of water, and in South Carolina about 49 inches, distributed quite evenly over the seasons, and free from interruption by ice blockades. The mountainous district from which the rivers receive their supply thus has one of the highest averages of rainfall in the United States.

Four main river systems, the Pee Dee, the Edisto, the Santee, and the Savannah are included in the state, and it is the tributaries of these rivers, such as the Catawba, the Broad, the Saluda, etc., which afford the power sites, estimated by the Bureau of Corporations as capable of developing more than 800,000 horse power.

In another place in this magazine, attention has been called to the importance of taking measures to construct engineering works to control the flood waters which occasion such devastation in certain parts of the United States, and the foregoing examples of hydraulic-power development indicate how the control of streams includes, not only protection against flood damage, but also the direction of the power of the water toward useful purposes.

It is the work of the engineer to take natural forces and divert them from working injury and direct them to the aid of man, and some of the best work which is being done by eminent engineering firms is along these lines.

It is in the conduct of such work that the functions of the engineer have taken on a broader aspect than was formerly considered advisable, and at the present time the operations of financing, construction, and operation are all coming under engineering control. This expansion of effort appears in the manner in which the firm of J. G. White & Company, Incorporated, has extended its operations, this involving the formation of subsidiary companies, known as the J. G. White Engineering Corporation, and the J. G. White Management Corporation.

The scope of the work of such organizations appears when it is understood that it includes, not only hydro-electric power plants, such as have been described above, but also the construction and operation of central stations, steam railways, street and interurban railways, gas plants, industrial plants, harbor improvements, waterworks, sanitation, sewerage, drainage, and irrigation systems.

It is by the utilization of such combined resources, skill, and capital, that the development of natural resources has become possible upon the large scale essential to success. Individual efforts lack the opportunity, and usually lack the means, while any attempts to conduct modern operations along the lines which were formerly considered suitable for manufacturing work must sooner or later form portions of larger undertakings, or fail of broad success. It is, therefore, most desirable that any modern development of natural resources should be planned in the first place by engineers of experience and ability in such extended works, even if the entire construction is not to be immediately

executed. The financial part of the operation demands familiarity with the real cost of such work, and with the manner in which the returns may be expected; while any system of operation which neglects to take the technical side of the work into account must surely fail of maximum efficiency.

It is, therefore, a matter of great interest to note the manner in which engineering concerns are broadening their scope, and co-ordinating the essential elements of finance, construction, and operation, into affiliated corporations, all working together toward the general success of the various undertakings, and each providing the especial skill and experience which its department of the work involves.

Of the total amount of manufactured power now developed in the United States, estimated by the Bureau of Corporations as thirty million horse power, about six million is developed from water-power. The total hydraulic power actually available is estimated at twenty-five million horse power, and if this were actually used it would release an equivalent amount of fuel for purposes other than power generation.

Most of this power is so situated that its development and utilization is impracticable other than by corporate effort on the large scale, and it is by the methods and equipment of such engineering concerns as have already achieved success in this field that future operations should be conducted.

THE TRACKLESS TROLLEY

One of the important elements in the cost of mechanical traction for public service lies in the construction of the track upon which the cars run, including the right of way and the necessary cost of maintenance.

It is for this reason that many localities are without transportation facilities, since capital waits until the probabilities of remunerative traffic may give some adequate return upon the outlay.

In some places, especially in cities, the motor omnibus enters into this field, but in the country the interurban electric railway is generally limited in its service to the main highways, where the traffic is sufficiently great to pay the operating expense.

There are many localities, however, in which the possibilities of electric traction appear to be great, if the construction of the railway could be eliminated, and it is in such places that the so-called "trackless" trolley offers many advantages. The necessity for a railway does not appear, when the roadway itself is well built, since vehicles for both passengers and merchandise may readily be operated upon the highway, and the principal question appears in the provision of motive power.

The use of the overhead wire for delivering electrical energy to vehicles upon the highway has been well known for several years in Europe, and the same method is now being applied to similar purposes in the United States. This method enables motor vehicles to be operated as feeders to interurban electric railways, or to steam railroads, in a very economical and efficient manner, since the current may be derived from existing power stations, and the only permanent investment appears in the cost of the overhead transmission line, and in the vehicles themselves. As the traffic warrants the expense, the railway line may be extended, and, at the same time, the overhead line carried forward to new extensions, thus keeping continually ahead of the demand, and developing the territory and creating new business.

Not only on the continent of Europe, but also in England, the trackless trolley has been found most effective in thus providing opportunities for the development of local transport, and there is every reason to believe that similar developments in the United States will follow the introduction of the system

The Trackless Trolley Company of America, 30 Church St., New York, has the conduct of the system in hand for the United States, and it is believed that its advantages will be found even greater in this country than abroad.

AIR-TRAVEL REQUIREMENTS

It is only natural that the development of the aeroplane should follow somewhat along the same lines as those which existed in the case of the automobile, but it is unfortunate that something more scientific should not have succeeded the period of experimental and hazardous exhibition flights. Sufficient time has now elapsed since the ability to fly was demonstrated by the Wrights, and the extent to which operators of biplanes and monoplanes have performed feats comparable with the most daring efforts of the tight-rope walker reveal the possibilities of the machine.

There has been some improvement in the motor, and the experiments of Eiffel and others have added to our practical knowledge of propeller construction. Apart from these, the most notable development has been that of a machine capable of alighting upon the surface of the water and of rising from it at will, thus furnishing vessels with a practical method of operating air scouting machines of a serviceable character.

With these exceptions, the principal events of recent date with the aeroplane seem to have been those which depended more upon the daring of the operator than upon the machine itself, while, at the same time, the loss of life has been such as to deter any but the most venturesome from undertaking ascents.

Those who recall the varied and almost grotesque designs of the earlier automobiles, and compare them with the present shapely, powerful and almost artistic vehicles, must realize the manner in which careful scientific study and the application of established principles of construction act to produce a correct machine. Similar work, devoted to the flying machine, should result in a corresponding degree of advance.

Broadly, all that we have found out is that certain shaped surfaces, when driven through the air at fairly high rates of speed, are supported, together with a certain burden of machinery and operators. The balancing must be effected mainly by the effort of the operator, using rudders, ailerons and apparatus for warping and inclining the surfaces.

At the present time the power is supplied by engines modified from those used in automobiles, consuming gasoline fuel and delivering the power to propellers similar to the type settled upon for the propulsion of vessels through the water. When we consider the crude manner in which these elements are being used it is something of a marvel that men can fly at all and that many should lose their lives in experimenting with such apparatus must be expected.

Knowing what we do about the flight of birds, and especially of insects, it seems as if the application of scientific analysis, combined with critical study of natural flights, should enable us to proceed at the present time along lines of definite improvement. It is not enough that certain venturesome men should be able, under satisfactory weather conditions, to risk their lives in flying a few hundred miles, in traversing the Channel, or in crossing an Alpine pass. These are marvelous achievements, but, unless something more controllable is accomplished, the aeroplane will remain where the balloon remained for a century after the time of Montgolfier, an exhibition device of little practical value.

There are certain things which an aeroplane must be capable of doing if it is to become a really useful machine, either for military purposes or for daily civilian service. It must be reasonably safe; it should be capable of ready control, both in the air and in rising and alighting; and it should be capable of hovering in the air over a determinate spot, just as an insect can hold itself definitely, both as to position and altitude.

How these points are to be attained remains to be settled. Some of them will depend upon the development of improved motors, in which ample power is combined with a high degree of control. Stabilizing need hardly be automatic, since such methods have not been found desirable in other apparatus, and in neither the art of walking upright in

a condition of unstable equilibrium, nor in riding upon such an unstable machine as a bicycle, does any necessity appear for a balancing apparatus. It is possible that some combination of the aeroplane and the helicopter may solve the problem of hovering; and it should be remembered that the aeroplane itself may be considered as a particular case of the screw of a helicopter, the planes forming portions of a screw blade of indefinitely great radius. It may be that a study of the movements of the wings of an insect in buzzing flight, using the rapidly moving photograph film to record the sequence of action, will reveal the secret of the sustaining effort, and in any case something different from an extremely rapid forward flight is desirable to furnish a really useful method of support.

When we consider the extent to which the testing tank has enabled problems of form, speed, powering and general design to be solved in the development of the steamship, it seems hardly necessary to impress the desirability of conducting similar investigations for the direction of the improvement of the aeroplane. Whether this is a matter for government undertaking or for private investigation remains to be seen. The earliest experiments upon ship models were conducted without official help, and it was only after the value of the method had been demonstrated that the larger government testing tanks were authorized.

It is probable that the usual tardiness of officialdom will appear also in connection with the study of the flying machine, and this is especially the case when it is realized that success in aerial warfare means a complete transformation of all the traditions of the military art. It is rather to be expected that either private enterprise, as in the case of M. Eiffel, or the activity of some of the endowed scientific institutes, will give to the engineering profession the necessary fundamental data upon which to erect the constructive methods necessary to make the aeroplane what it really should be, a machine which will render transport through the air, independently of local conditions, a thing as practical as now exists upon the road in the case of the automobile.

WHAT IS EFFICIENCY?

In view of the interest which is being taken at the present time in the subject of efficiency it is desirable to note that there is no one definition of the term "efficiency" which is generally accepted by those who are endeavoring to promote its development in industrial operations. In the various departments of physical science there is generally a maximum possible performance to which all others may be referred, and the expression of the efficiency of any operation is thus correctly given as the percentage of the maximum which has been attained. We know that 778 foot-pounds of mechanical energy represent the equivalent of a British thermal unit, and, upon this as a basis, we may compute definitely the efficiency of any apparatus which is used in the conversion of heat into work. When, however, the effort of a man, or of a machine, is under consideration there is no such positive basis. It has been said that efficiency is the "ratio of what is, to what ought to be," but that leaves the value of what "ought to be" to be decided, and the final efficiency thus computed will depend as much upon the estimate of what ought to be, as upon what is.

The great difficulty in measuring the productivity of men lies in the idea of comparing one man with another upon a basis of work under normal or average conditions. To do this is to place a man upon a mechanical basis, while the very difference between a man and a machine lies in his mental capacity, something which is wholly lacking in any mechanical device. Any work which is of a repetitive or routine character can be performed much better by a machine than by a man, and, no matter how complicated it may be, it must be capable of reduction to mechanical movements as fully as did Babbage with the mechanical computation of logarithms, or Jacquard with the weaving of most elaborate patterns.

Many persons confuse the term "efficiency" with the word "effectiveness," and while there is a current usage in which the two terms overlap, yet the difference is easily capable of detection.

Thus, when a piece of work is well and promptly done we may say that it is efficiently performed, or that it is effectively done. When, however, we attempt to give some precise value to the performance it will be found that it may be expressed either positively in terms of some concrete unit, or comparatively, as a ratio or percentage, this latter only being an efficiency. The great thing to bear in mind when considering efficiency is that it necessarily involves two quantities, and that the efficiency is the result obtained by dividing one of these by the other, so that an efficiency must always be expressed as a fraction, which may be either in the vulgar or the decimal form, the latter being very generally preferred.

Since the value of a fraction may be varied by varying either the numerator or the denominator, it follows that both of these must be positively determined if the result is to be a determinate quantity. A very common error is to measure the numerator, the performance under observation, very accurately, and to use a denominator which is uncertain; or which, indeed, is impracticable of precise determination. One is reminded of the individual who is said to have paced the diameter of a circle, and then used a value of π to seven decimal places as a multiplier to find the circumference.

Thus it appears that the real difficulty in discussing the efficiencies of workmen lies in the impracticability of finding out the correct value of the denominator of the fraction. Ordinarily this is done by using experts to make so-called "time studies," employing their judgment to deduce from such investigations just how much better the job might be done, thus finding out "what ought to be."

At the present time, and until productive mechanical operations are more generally performed automatically, it would seem as if the best work of the efficiency engineer would be that directed to the reduction of wastes, since this will assuredly increase efficiency even though the amount may not be precisely capable of numerical computation. It is along such lines that the greatest advances have already been made.

The real value of computed efficiencies lies in the extent to which they indicate the direction in which efforts may best be directed. When it is known that very high efficiencies in certain directions are already being attained it is well to devote the most attention to other departments of work which have not yet reached such a position. It is also important to give especial attention to those operations which operate in series, so to speak, and in which the sequence of events renders the final efficiency the continued multiple of the efficiencies of the entire series. Even a moderate improvement in each of the factors of such a series will make a considerable increase in the final efficiency.

Sometimes the effort to secure a satisfactory definition is given more attention than the attainment of the really valuable result, and, while there may be differences of opinion about the best definition of efficiency, there can be no disagreement as to the fact that efficiency is increased by the reduction of waste.

HOW MACHINERY MULTIPLIES POWER

Some interesting facts have been gathered by the Bureau of Labor with reference to hand and machine labor. Aided by machinery, it appears, four million five hundred thousand men turn out a product which would require the labor of nearly forty million men, if produced by hand. In the United States the advantage derived from machinery is about twice as great as in Europe, so that the actual population of the United States is equal in productive power to one hundred and fifty million Europeans. With labor-saving machinery, one generation of men can do the work of four or five generations of hand-workers.

THE REGRADING OF PORTLAND, OREGON

The Railroad Trestle at Portland, Oregon, showing a view of Guild's Lake, through the grounds of the old Lewis & Clarke Exposition. Hydraulic excavation work under operation in foreground.

Excavating Goldsmith's Hill by the hydraulic process in the regrading operations at Portland, Oregon. The composition of this hill is especially gravelly. The streams, therefore, are directed by huge nozzles so as to undermine the lower part of the bank, and the weight of the material above brings down the sand and gravel from the working face. From here it is washed through the sluiceway into Guild's Lake.

View at 24th and Raleigh Sts., Portland, Oregon, before regrading operations had begun.

MECHANICAL SERVANTS

One of the greatest impediments to the more rapid replacement of human physical effort by machinery appears in the apprehension of the workman that the change will leave him stranded and helpless; that his job will be taken from him, and that he will be condemned to the dreaded condition of involuntary idleness.

It has been said that the chief element in fear is the unknown, and many things of which men were formerly afraid have been found to be either harmless or helpful as soon as a fuller knowledge about them was obtained. That this is true of the machine will be discovered as the facts become more generally understood, and the terror of the mechanical supplanter will take its place by the side of other ghosts which were shorn of all influence when the light was turned upon them.

Even today the old idea of the "lump of labor" is still held by many men whose eyes should teach them better. That one man will have less to do because someone else does more is a fallacy which needs only observation for its disproval. We admit that facilities create traffic because we know that whenever new opportunities for the development of industries are provided the activities of commerce respond. We must also admit that the greater the improvement in methods of manufacturing the more opportunities are provided for the employment of men. Every industry which has grown up by the aid of machinery is evidence of the extent to which mechanical appliances are not "labor-saving machinery" but "labor-making machinery," not only by reason of the greater markets which are made possible, but also because of the wholly new occupations developed in the production of the machines themselves.

It has been said that the replacement of the ordinary workman by the more or less automatic machine will deprive many men of the opportunity to work because such a changed order of things will give occupation only to men of a higher order of intelligence, and that a large number of men will thus find the only kind of jobs possible are those which they are incapable of performing.

If it is true that the relief of man from such brutal kinds of work as puddling iron, stoking marine boiler furnaces, and the like, is to be accomplished by machinery, the sooner such developments are completed the better for the welfare of the human race. As a matter of fact, there are few workmen who cannot readily accommodate themselves to tasks involving the use of their intelligence, and the whole record of history shows a gradual elevation of the character of human labor by the gradual elimination of burdensome effort.

When there appears a demand for a new kind of service, different from what has gone before, there is little lack of men capable of filling the requirements. Ten years ago the automobile was little more than an experiment, and its operation was an art yet to be learned. In the time which has elapsed there have been hundreds of thousands of men provided with abundant opportunities of earning good livings driving such machines, and it has been found that men of moderate ability, according to their former standards of occupation, have readily learned the new and desirable trade. When the electric street railway came into use it was not found difficult to make good motormen from material which had formerly been contented with much less responsible work, and there is every reason to believe that the latent capacity for better service exists in many, if not most, men who have hitherto had no opportunity for development.

When, about a hundred years ago, the development of the factory system began, as a consequence of the introduction of manufactured power, the drain of men from the country farms, and their concentration in the manufacturing cities and towns was deplored as a social change of a disadvantageous character. It has been argued that the re-

turn of great numbers of men to the cultivation of the land, consequent upon the reversal of this concentration, might be a most desirable result of the introduction of machinery which would transform the factory system. In some instances, such a change has already been inaugurated, and this is but a hint concerning the general nature of the uplift which may follow the release of human muscle from its burden.

THE SCOPE OF EFFICIENCY

There appears to be an unfortunate tendency on the part of many persons to regard the present active movement toward the development of higher efficiency as little more than an attempt to urge the introduction of what has been termed "scientific management" into manufacturing establishments, and to promote the activities of specialists in the reorganization of methods of shop administration as they exist at the present time. The whole movement is really far broader than is indicated by any such limitations, and it is most desirable that it should be considered in its widest scope and not deprived of any of its important possibilities.

It is only necessary to look about us to perceive how extremely inefficient nearly all of our preesnt ways of doing things are, and the most casual observer cannot fail to see, without any explanation, how many of the things of our daily life are continually done in a most crude and undesirable manner. Even such a simple thing as walking along the street is done, regardless of any well-defined respect for the "rules of the road," and people keep dodging along in the face of those who are approaching, often in apparent ignorance that there is any real reason for the irregularities. It is only within a very few years that the introduction of police traffic regulations has made the confusion and jam of carts, wagons, cars and other vehicles a thing of the past; and yet, in all the years which preceded, the cause of the inefficiency was plainly evident to every observer. From ancient times it has been realized that unity of action, and systematic methods of movement, were essential to the handling of large bodies of men in military operations, but the conduct known to be necessary in operations of destructive warfare is only beginning to be introduced into the peaceful walks of life.

In certain departments of work there appears to be a high appreciation of the importance of efficient methods, while side by side with these there may be found an utter lack of anything like a provision for minimizing wastes. Thus, in the operation of a railway system, the dispatching of trains, and their control while in the station, in the yard and upon the road, may be regulated in a very efficient manner, while, at the same time, there is practically no attempt made to provide for the systematic and scientific direction and guidance of the people to be transported in those trains. The handling and delivery of merchandise, the maintenance of continuity in the movement of all kinds of traffic, and the general elimination of interruptions, all provide ample opportunity for that reduction of waste which is the prime element in all such matters.

It is probable that the idea of the close relation of improvement in efficiency with systems for the management of workmen, originated in the fact that this department of activity is in especial evidence at the present time, but any general view of the manner in which most undertakings are conducted will show that there is room for improvement on nearly every side, and that it is possible to reduce wastes of time, effort, material, money and energy in nearly every thing which is done.

UTILIZING A WATER FRONT

It is very often difficult for men who are engaged in any well-established undertaking to perceive that other methods than those to which they have long been accustomed have any points of superiority.

The railroad man, used to the terminal station, for passengers and for

merchandise, naturally thinks that such a terminal is the natural and logical place into which to dump his living and inanimate freight, and thus is apt to forget that the station is a relic of former methods, and that it should be considered only on its merits, and not as having any preordained superiority over other possible methods of distribution.

In certain cities, in which no especial opportunity for immediate distribution of merchandise appears, it is probable that the delivery to a central freight station, and a subsequent distribution, by means of teams, may have to be accepted as the only practicable method, but this is not always true.

In the case of a city like New York, in which the peculiar outline of the territory provides extended stretches of water front on two sides of a long parallelogram, there appears such a remarkable opportunity for distribution by water that any plans for the delivery of merchandise directly into the city by the railways, followed by a distribution through the streets, will not bear comparison.

In order that the full benefits of this extended double water front may be obtained, it is necessary that a systematic plan be made and operated, involving receiving and delivering stations at the foot of selected cross streets, the merchandise being classified at the railway terminals on the opposite side of the rivers, and delivered by water to the receiving station nearest the destination. A systematic equipment of motor trucks, serving only the comparatively small area tributary to each river-front station, would then be able to complete the delivery in minimum time and with maximum efficiency. The cost of installation would compare favorably with that of tunnels, bridges and freight terminals within the city, and the efficiency would be vastly greater.

When it is realized that distribution costs form a very large proportion of final costs of merchandise delivered in a great city, it is evident that improved distribution systems offer marked opportunities for cost reduction, and that some such method provides opportunity for reducing delays, congestion and expense. It seems certain that any method which includes bulk delivery within the city, and subsequent distribution, by means of teams, involves a deliberate abandonment of the great natural distribution facilities which already exist in the combination of ample water fronts upon a long and narrow strip of land.

DANGEROUS MACHINERY

There has been much talk of late about the development of safety appliances for the protection of workmen from injury, and doubtless much good has come from the agitation. Exhibitions of dangerous machines, and of attachments to render them safer, have been held in various places and a general campaign of education is going on.

It is undoubtedly necessary to provide safety attachments for use with dangerous machines already in use, but in nearly every instance it will be found practicable to design the machine itself in such a manner that no protecting devices will be needed. Already this method is beginning to appear, and many modern pieces of machinery will be found with coverings for gear wheels, shield for moving parts in which operators may become entangled, etc. This desirable method, however, has not been so generally adopted but that attention may be directed to it in this place, and the suggestion made that such preventive measures should be included in the original designs of machine tools and other apparatus more effectively if it were found difficult to sell the older and more dangerous apparatus. The extent to which employers are held liable for injuries to employees has had much to do with the introduction of safety appliances in many manufacturing establishments, and if the same employers declined to purchase machinery which required the addition of protective devices at the purchaser's expense, the dangerous machine would soon become a thing of the past.

The tendency in nearly every department of activity is to wait until something undesirable happens, and then to try to

remedy the evil. Until recently this has been the general trend of the practice of medicine, and the "cure" was the thing; but, with the development of modern methods, the great thing is prevention. In like manner the real aim of the engineer in designing power machinery for the relief of mankind from the burden of heavy labor should include such detailed construction as would render injuries impossible, or at least very remote.

The more nearly automatic the apparatus is made the less probable is the contact of the operator with the dangerous parts, and this, in itself, is a strong argument for the control of operative machinery by appliances which remove the attendant from immediate contact with the working parts.

One of the reasons why many machines have been devised in the past with but little regard for the safety of the operators is that the men by whom they are designed are often unfamiliar with the actual conditions of their use. Too often the engineer and draftsman consider only the operative conditions of the apparatus, and have closely before them the work to be done, considered apart from the surroundings in which the machine is placed, and about which they concern themselves but little. In other instances the nature of the dangers accompanying machinery in operation are but imperfectly understood. Thus, for example, the layman naturally considers that the principal danger accompanying the use of the circular cut-off saw is that of having the fingers cut off, and various guard devices have been made to protect the operator from such a mishap. A frequent cause of injury, or even death, with such a machine, however, appears in the manner in which the short end of the piece which is cut off may become caught in the teeth of the saw at the back and thus picked up and thrown violently over the saw directly at the head of the workman, inflicting serious injury. It is entirely possible to provide a shield to protect the operator against such missiles, but the designer of the machine hardly ever thinks of the existence of such a danger, or provides any guard against it.

The most effective method of protecting operators from injury in any department of work seems, therefore, for the purchaser, who himself is familiar with the work and its dangers, to insist upon machinery in which the original designer and constructor have incorporated the protective devices as an integral part of the machine, and, of his own knowledge and experience, to judge how far the actual operative dangers have been perceived and met.

THE NEW YORK COURT HOUSE

The award of the commission to Architect Guy Lowell to build the mammoth New York Court House is an event worth noting. Mr. Lowell was awarded this prize in competition with the very best and most popular architects of the country. He presented an absolutely new, original and revolutionary treatment of the problem. Usually, people are chary of adopting anything novel, for the thrall of the ordinary is strong upon us; but apparently Mr. Lowell's plan carried the jury off its feet, for the award was made to him not only unanimously but without the slightest hesitancy, virtually placing his plan "hors concours," or above and beyond competition.

True, the circular plan is an old Roman conception, but to adapt it to the exceedingly modern needs of a Court House was a daring venture, and, judging from what has been published of the design, is as splendidly successful as it is daring. Indeed, Mr. Lowell has shown us the one really new and original architectural conception of this present generation, for it is nearly thirty years since any such startling innovation has been made in the science Architectural. Thirty years ago the tall building, the metal structure scheme, was first launched. That and this plan of Mr. Lowell's are the two really notable departures from the hackneyed, the ordinary, the well-precedented, beaten rut that our architects have traveled for the past fifty years.

FINANCIAL DIGEST
OF THE INDUSTRIAL WORLD

INFORMATION ON INDUSTRIAL AND OTHER SECURITIES OF VALUE TO INVESTORS AND MEN OF AFFAIRS

SUBSCRIBERS AND READERS of this Magazine have the privilege of securing an expression of opinion on any investment or financial matter. There is no charge for this service, as it is the desire of this Magazine to serve in every way possible the best interests of its patrons. All inquiries are to be addressed to the Financial Editor.

CHARLES EASTON, Financial Editor.

THE SITUATION

In spite of the fact that there has been a moderate reduction in trade and industrial activity, it is encouraging to note that confidence very generally prevails throughout the business world.

The money market, both at home and abroad, is fairly easy, although not entirely satisfactory. There is some anxiety over the Balkan situation; otherwise, international conditions are not particularly disturbing.

From an agricultural standpoint, we are in better shape than Europe. Optimistic reports come from both the South and West, due, no doubt, to the splendid crop outlook. In Eastern centers, however, a more conservative feeling exists, because of the proposed drastic revision of the tariff.

While we do not wish to minimize the importance of tariff legislation, and its disturbing effects upon business, yet we are inclined to the belief that the extreme caution and uncertainty inspired by pending legislation of this character are in a large measure unwarranted.

Unquestionably, certain lines of industry will experience losses during the period of tariff readjustment; but there is a growing belief that the effect will not be as disastrous as some have prophesied.

There has been a considerable falling off in textile lines, but the fact that retailers have allowed their stocks to become reduced gives reason to anticipate increased buying orders at a very early date.

The excellent weather conditions have given an impetus to the real estate market and building operations. The iron and steel trade continues prosperous, although there is not the pressure of new orders that was apparent a few months ago. Railroad gross earnings have recently decreased somewhat, but the aggregate will probably show substantial gains over the corresponding periods of last year. To some extent, at least, this is due to the favorable operating conditions during the past winter. The net earnings of railroads, however, are rather unsatisfactory. The inability of the roads to advance rates while wages have been steadily increasing is mostly accountable for this poor showing. The result is that many roads are confronted with the serious problem of making ends meet.

Generally speaking, our troubles are more apparent than real. Most of them are directly traceable to the bad practices of previous years—overcapitalization, abnormal extension of credits, frenzied speculation and a wholesale disregard for the rights and welfare of the people by many large corporations.

To this and the indefinite and ineffective method of government control are chargeable most of the ills that today seemingly beset the commercial world. No doubt, a change for the better has been going on for some time, especially since the panic of 1907. This change has been particularly noticeable in the financial field, where improvement was most needed.

Slowly, but surely, matters pertaining to stocks, bonds and finance generally are adjusting themselves to a more conservative and substantial basis. The investing public, whether it is aware of

the fact or not, is forcing a great reform in methods of finance. The most effective implement they have thus far employed has been a persistent determination to stay out of the speculative market. When the public refuses to be inveigled into buying stocks on small margins for speculative account, the practice of stock jobbing ceases to be either profitable or popular. Investors today are looking for surety of income and safety of principal rather than speculative opportunities.

BUSINESS NOTES

It is stated that two billion dollars' worth of merchandise is now being imported annually into ports fronting upon the Pacific Ocean. Approximately ten per cent. of this is drawn from the United States, twenty-five per cent from the United Kingdom, eight per cent from Germany, and seven per cent from other European countries, the remaining fifty per cent being drawn from areas adjacent to the importing port or country.

For the first time direct communication has been established between the wireless station on the Eiffel Tower, Paris, France, and the one at Arlington near Washington, D. C. The station at Arlington has been able for some time past to pick up messages sent out from the Eiffel Tower, but the latter has not hitherto been able to receive those sent out from Arlington. The distance is over four thousand miles.

It would seem that Representative Henry of Texas, Chairman of the Rules Committee, has designs upon the "Rule of Reason" established by the Supreme Court in its interpretation of the Sherman Anti-Trust Law. Mr. Henry proposes to define the specific acts prohibited. His bill defines conspiracy, monopoly and restraint of trade, providing penalties of from two to ten years imprisonment. "Trust-owners and organizers should be sent to prison," said Mr. Henry, "and their products made free of duty."

The aggregate value of shipments from Germany to the United States and its possessions during 1912, was $193,809,158. The increase amounted to over 12.890 per cent, as compared with 1911.

The Standard Oil Company has been sued by the State of Texas to recover approximately one hundred million dollars for alleged violation of the Anti-Trust statutes of that state. The substance of the allegations of the Attorney General of Texas is that the Standard Oil Companies of New York, New Jersey, Kentucky, Ohio and Indiana are practically under one control. It is, further, set forth that the Standard Oil "Trust" still exists and operates the Magnolia Petroleum Company as its Texas branch.

Remarkable growth in United States exports to South America from $38,500,000 in 1902, to approximately $138,000,000 in 1912, is shown in a statement issued by the Bureau of Statistics. The percentage of gain in the exports to that continent is much greater than in any other grand division of the world.

In the United States during 1912, fire destroyed property valued at $207,543,900. This was about one hundred million dollars less than was destroyed during 1911. Fire insurance rates in the United States are about ten times as high as in any country in Europe, except Russia. It is interesting to note that in most places in Europe it is a misdemeanor to cause fire from negligence.

Prices of automobile tires have gone down considerably. This is due perhaps to the fact that there are many makes of good tires now in the field. However, the automobile owner hardly had time to become inflated over this good news until he was punctured by a substantial advance in gasoline.

The sale of safety razors in France has assumed such proportions that the United States Consul in Paris has issued special memoranda on the subject. He points out that while in Paris the safety razor now far exceeds that of the old-fashioned, hollow-ground, the French market generally is at present superficially dealt with and the opportunity of the American manufacturer is almost illimitable.

CASSIER'S CATALOGUE

FOR ENGINEERS
CONTRACTORS AND
MANUFACTURERS

ARRANGED FOR QUICK REFERENCE

JUNE, 1913

PROMPT ATTENTION TO ALL REQUESTS FOR SPECIAL INFORMATION. ADDRESS SERVICE BUREAU, CASSIER'S ENGINEERING MONTHLY, 12 WEST 31ST STREET, NEW YORK

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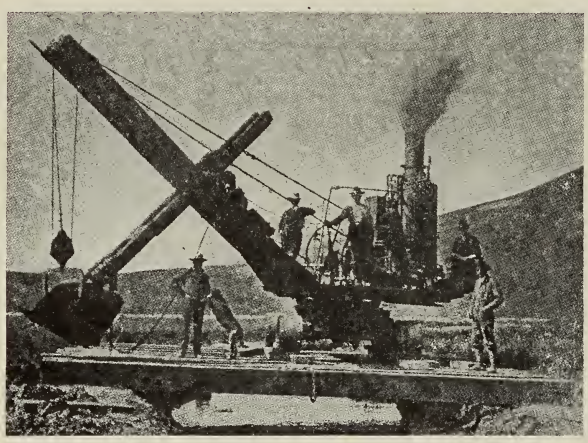
THEW SHOVELS FOR DITCH CONSTRUCTION

Hydraulic mining methods for placer work frequently necessitate the construction of ditches under conditions involving excessive costs for labor and teams. Ordinary excavating machinery cannot be employed, not being adapted for light work, and further, being precluded by the expense and difficulty of transportation.

THE SPECIAL No. 0 THEW SHOVEL



DITCH CONSTRUCTION IN ALASKA

shown here is designed to meet these requirements. It weighs only twelve tons, and when dismantled the heaviest package need not exceed two tons in weight. It has a dipper of five-eighths yard capacity, swings through a complete circle and may be mounted either upon traction or car wheels. The boiler permits the use of coal, wood or oil as fuel.

Under the conditions shown in the cut, the shovel averaged over 150 cubic yards per shift. In surface excavation this can be doubled or tripled under favorable conditions.

SHOVELS FOR ALL CLASSES OF MINING OPERATIONS

EQUIPPED FOR

STEAM, COMPRESSED AIR OR ELECTRICITY

WRITE FOR INFORMATION

THE THEW AUTOMATIC SHOVEL COMPANY

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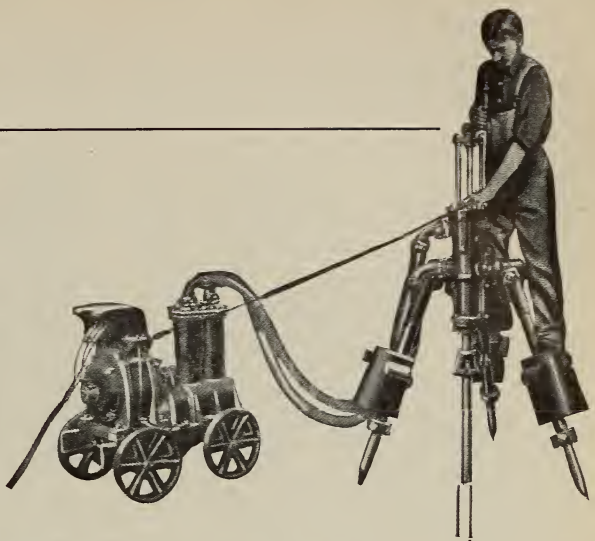

A FACT CONCERNING THE "ELECTRIC-AIR" ROCK DRILLS

During the past twenty-five years, the efforts of able engineers and inventors have been devoted to the production of a successful "electric" drill, and millions of dollars have been expended on the problem.

The fact remains, however, that the "Electric-Air" Rock Drill is today the only successful means of drilling rock by electric power —combining, as it does, the economy of electric transmission, the power of compressed air, and the rugged reliability of the standard air driven rock drill.

BULLETIN 4209

INGERSOLL-RAND CO.

NEW YORK ✦ LONDON

Offices in all Principal Cities of the World

COMPRESSORS ROCK DRILLS ELECTRIC-AIR DRILLS
CORE DRILLS PUMPS PLUG DRILLS PNEUMATIC TOOLS

Something New

This new departure in pit jacks has already gained great favor among railroad men. Perhaps you have read the description in recent issues of the railroad magazines.

The old, slow, hand-pump method is displaced by a quick, sure, economical, air driving method. As one man expressed it, "It works like a charm." The time and labor it saves will quickly pay for the whole jack.

Further, if you have one of our pit-jacks now, and wish to equip it with an air engine, it may interest you to know that *any standard Watson-Stillman pit-jack can be equipped with very slight alterations.*

The capacity of this jack is 10 tons; track gauge 24 in.; side adjustment 6 in.; wheels 14 in.; pit track to saddle with ram down 3 feet 4 in.; approximate weight with pump, 1,000 pounds. Wheels are mounted on ball bearings to eliminate high starting friction.

Whether you want the above jack or engine or not, we can no doubt interest you in one of our many other hydraulic tools—jacks (shown below), punches, shears, pumps, benders, presses, accumulators, etc. We build over 4,000 complete machines, and as we have so many patterns in stock we can usually make special machines at low cost.

Consult our engineers for special information. Submit blueprints and specifications. Ask for literature and prices. We will gladly do what we can to fill your hydraulic requirements.

DRIVE YOUR PIT-JACKS WITH COMPRESSED AIR

The Watson-Stillman Co.

ENGINEERS AND BUILDERS OF HYDRAULIC TOOLS

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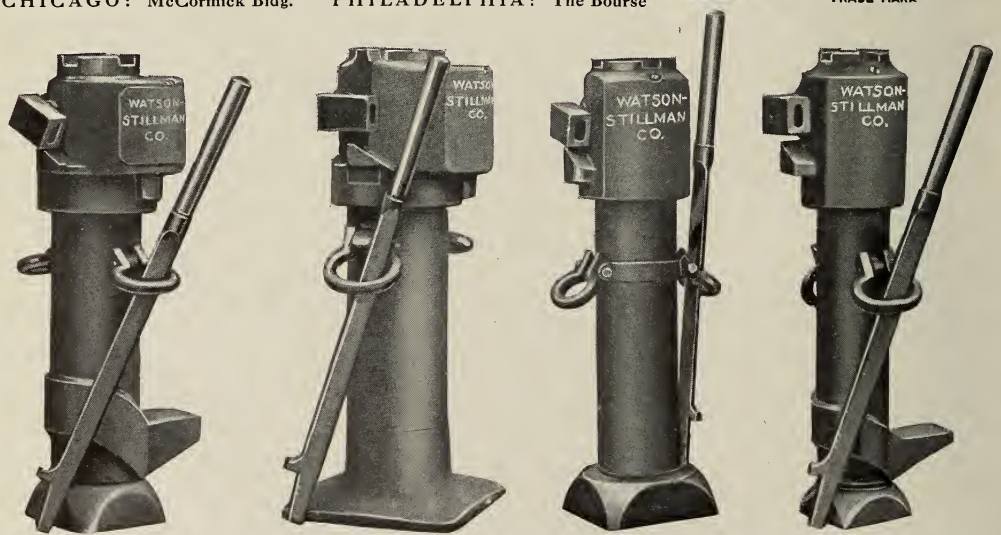

A FEW OF OUR MANY TYPES OF HYDRAULIC JACKS

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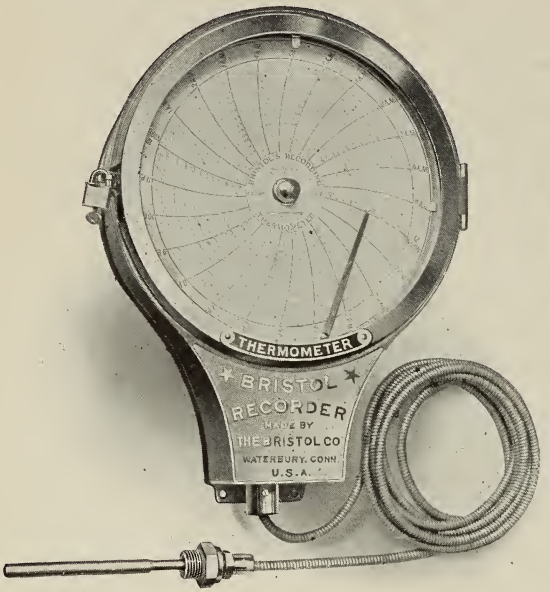

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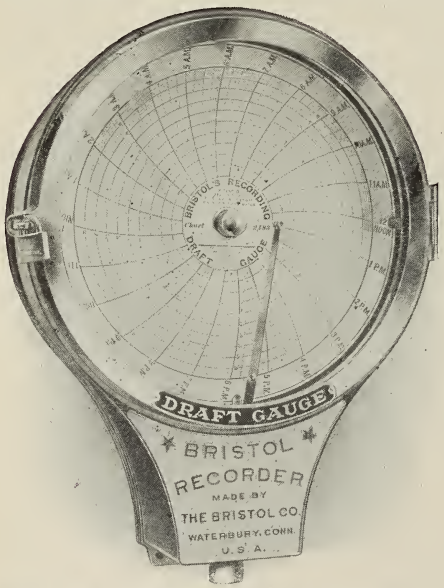

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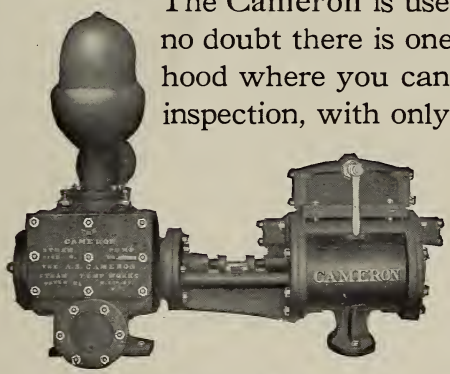
THE more you know about pumps, the more will the simple design of the Cameron appeal to you.

By merely removing a bonnet or cover, the valves of the water valve chest are at once visible and readily reached. There's no outside valve gear about the Cameron—not a thing that is complicated. But the Cameron will repay a closer examination than is given here. The best way to know the Cameron—next to owning one—is to see it at work and hear what users say about it. The Cameron is used everywhere, and no doubt there is one in your neighborhood where you can make a personal inspection, with only an unbiased user to influence your opinion.

The purchase of a Cameron means years of satisfaction.

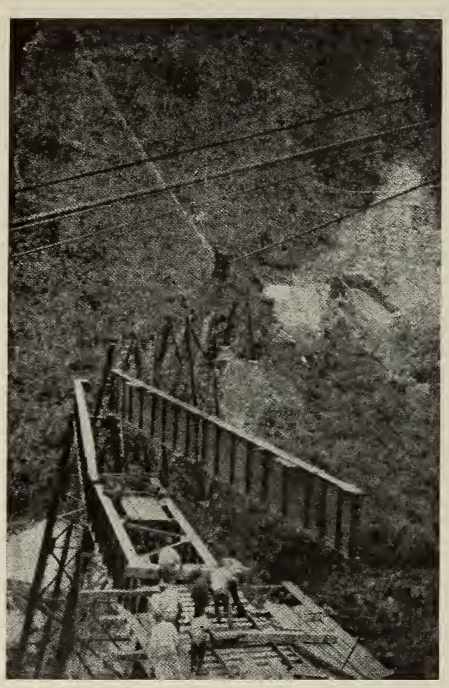


Regular Pattern
"CAMERON" SIMPLICITY

STEAM PUMP WORKS

NEW YORK

YELLOW STRAND ROPE



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This time is was in bridge building.

There were ten steel railroad bridges built—the illustration shows one.

The main cable is a 2½-inch YELLOW STRAND about 800 feet long.

The Supt. of Bridge Erection writes: "The load line also the in-haul and out-haul are your ⅝-inch YELLOW STRAND, 19 wires to the strand. The large girders which are shown in the photo weigh 15 tons each, which the cable handles with perfect ease."

Then he adds—for good measure—"I consider YELLOW STRAND the best cable made."

YELLOW STRAND retains its strength and elasticity after heavy service demands have been put upon it. Cheap rope stretches and stays stretched. But YELLOW STRAND stretches and RECOVERS. It's all a question of quality.

For mining work there is no other rope so safe and so truly economical as YELLOW STRAND. Investigate. Write for Catalog No. 7 and prices.

Broderick & Bascom Rope Co.

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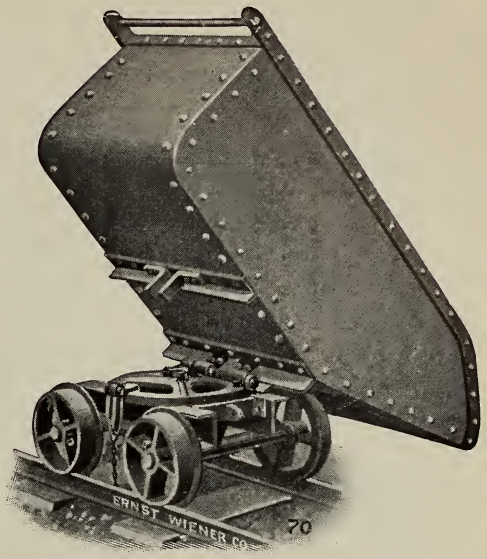

This type of Car dumps sidewise or endwise in any direction.

They can be equipped with end gate, thus making an excellent Car for concrete work.

One man easily dumps it. Use these Cars on your job and you will reduce the cost of handling material.

These Cars carried in stock, also rails, portable track, turntable, and various other types of Cars.

Catalog 206 gives complete details. Write for a copy and prices—before tonight.

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Agents for Industrial Locomotives of the Baldwin Locomotive Works

(We give below in full the famous Barrett Specification)

The Barrett Specification

FOR STANDARD GRAVEL or SLAG ROOFING (Over Boards) . . . . .

(To follow description of Roof Sheathing.)

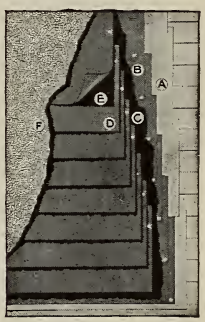
OVER the foregoing shall be laid a Coal Tar Pitch, Felt and Gravel or Slag Roof.

There shall be used one (1) thickness of sheathing paper or unsaturated felt, five (5) thicknesses of Barrett Specification Felt weighing not less than fourteen (14) pounds per one hundred (100) square feet, single thickness; and not less than one hundred and twenty (120) pounds of Barrett Specification Pitch and not less than four hundred (400) pounds of gravel or three hundred (300) pounds of slag from ¼ to ⅝ inch in size, free from dirt, per one hundred (100) square feet of completed roof.

The material shall be applied as follows:

First—Lay the sheathing or unsaturated felt (A) lapping each sheet one (1) inch over the preceding one.

Second—Lay two full thicknesses of tarred felt (B) lapping each sheet seventeen (17) inches over the preceding one, and nailing as often as may be necessary to hold the sheets in place until remaining felt is applied.



Third—Coat the entire surface of this two ply with hot pitch (C) mopped on uniformly.

Fourth—Lay three (3) full thicknesses of felt (D), lapping each sheet twenty-two (22) inches over the preceding one, mopping with hot pitch (E) the full width of the twenty-two (22) inch lap between the plies, so that in no case in the last three plies shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth—Spread over the entire surface of the roof a uniform coating of pitch, into which, while hot, imbed the gravel or slag (F). The gravel or slag must in all cases be dry.

NOTE—The above specification is designed for roofs having a pitch not exceeding three (3) inches to the foot. For steeper surfaces we will submit special Specifications upon request. A special Specification, when roof is to be laid over concrete, may be had by addressing the nearest office of

The BARRETT MANUFACTURING CO.

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ILLUSTRATION No. A-915

Excavating a canal with Hayward Skid Excavators. Notice the clean-cut appearance and regular slopes, an important consideration in canal work.

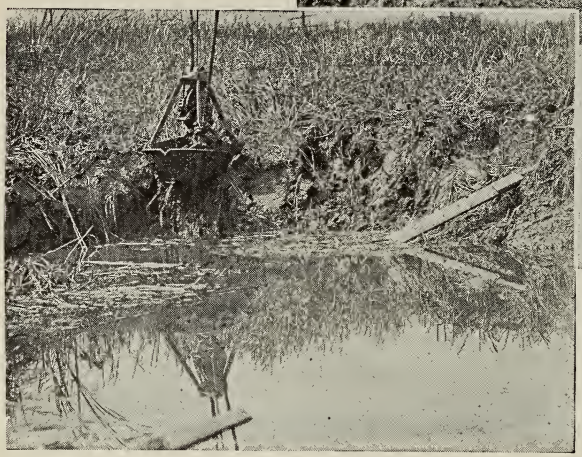

ILLUSTRATION No. C-181

A Hayward Bucket being used on a floating machine, excavating through heavy turf, snags and "saw grass."

Neither the Depth Nor the Width of the Excavation Makes Any Difference

Hayward Skid Excavators and Hayward Floating Dredges are not handicapped in their operation because the width of the excavating is too great. Hayward Buckets can be operated upon booms of any length.

Neither does depth of digging bother this superior excavating apparatus. In cases where great depth of digging is required, "Dipper" Dredges are useless. But Hayward Machinery will dig to any depth, for the Hayward Buckets are only limited in the depth of digging by the length of the operating lines.

Hayward Excavating Machinery

is desirable for many other reasons than their better work. They have a lower first cost. Their cost of operation is lower. They are light of weight and are easily moved. They can work alone or in pairs. They can be used on land or on scows.

Illustration C-181 shows a Hayward Bucket digging through heavy turf, snags and saw grass. Hardness and compactness of material govern the size and type of the bucket to be used. The sizes for canal work range from 5 cubic feet to 3 cubic yards. The buckets can also be used in rehandling crushed stone, sand or whatever materials are needed in construction work.

Illustration A-915 gives an idea of the clean-cut work a Hayward Skid Excavator does in digging a canal, giving regular slopes to the banks.

No matter how large or how small your needs, nor what the material to be excavated or rehandled, write and tell the problem and the conditions surrounding the work.

WRITE FOR CATALOGUE, STATING REQUIREMENTS

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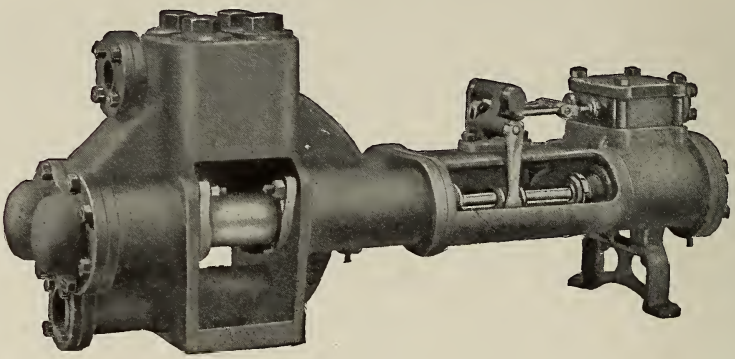
WORTHINGTON



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Packed Plunger Pump

300 POUNDS PRESSURE

This is a high-class heavy pattern pump, considerably less expensive than the ordinary type of separate valve pot pattern. Especially suitable for high pressure boiler feed work, low pressure accumulation service and general service.

Write for Bulletin W-191-36

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The "oldest inhabitants" said that a motor truck could never climb the banks of the gullies (often slushed with snow and mud) on the 90-mile round trip from Jersey Valley Mines, Battle Mountain, Nev., to the shipping point.

But our truck makes the trip in 9 ½ hours going out (loaded) and 7 hours for the return (empty). The twelve mules required five days for a trip and a day's rest between trips.

The truck delivers 15 tons while the mules delivered 6 tons.

The freight charges with mules was $20 per ton—the truck will deliver its entire 6-ton load for practically that amouut.

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Let us prove what our trucks are doing on mountain and desert trails.

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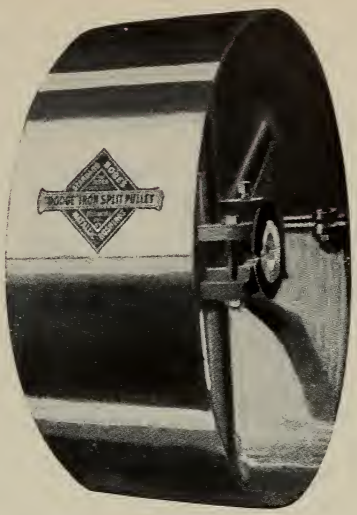
Canadian Sales Agents: Canadian Fairbanks-Morse Company, Limited, Montreal.

DODGE SPLIT IRON PULLEY



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Many tests under actual working conditions have demonstrated that the pulley is held fast to the shaft with absolute security by compression alone. The hub bolts are large in diameter and the clamping power therefore is much greater with these pulleys than any other type. This makes set screws unnecessary, and as they are an element of danger, projecting as they do from the hub, they have been, in the interest of safety and efficiency, eliminated.

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Before Revolvator was used seven men were required to stack bales in this mill.

By applying scientific management principles you may increase the efficiency of your manufacturing department. But it is certain that you can increase the efficiency of the storeroom force by 400 to 500%, by using a **Revolvator,** or portable tiering machine for handling material.

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Write for our Catalog C. M. "Scientific Tiering" and find out how hundreds of plants have accomplished this saving.

New York Revolving Portable Elevator Co.

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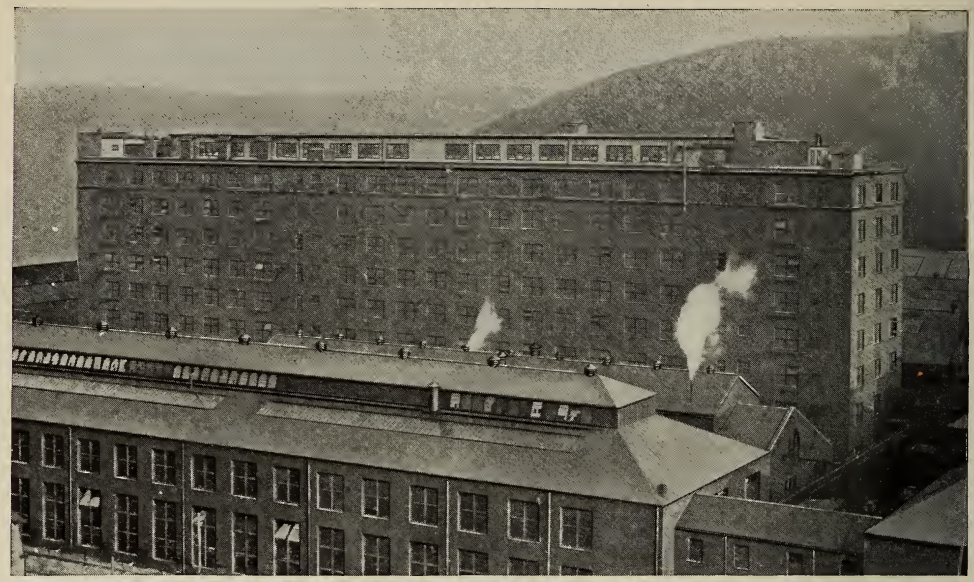

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WESTINGHOUSE Switchboards are designed and built in our own works from start to finish. Each individual detail is made by an expert, and the complete board assembled on the floor before shipment by men who, for years, have made a specialty of this kind of work.

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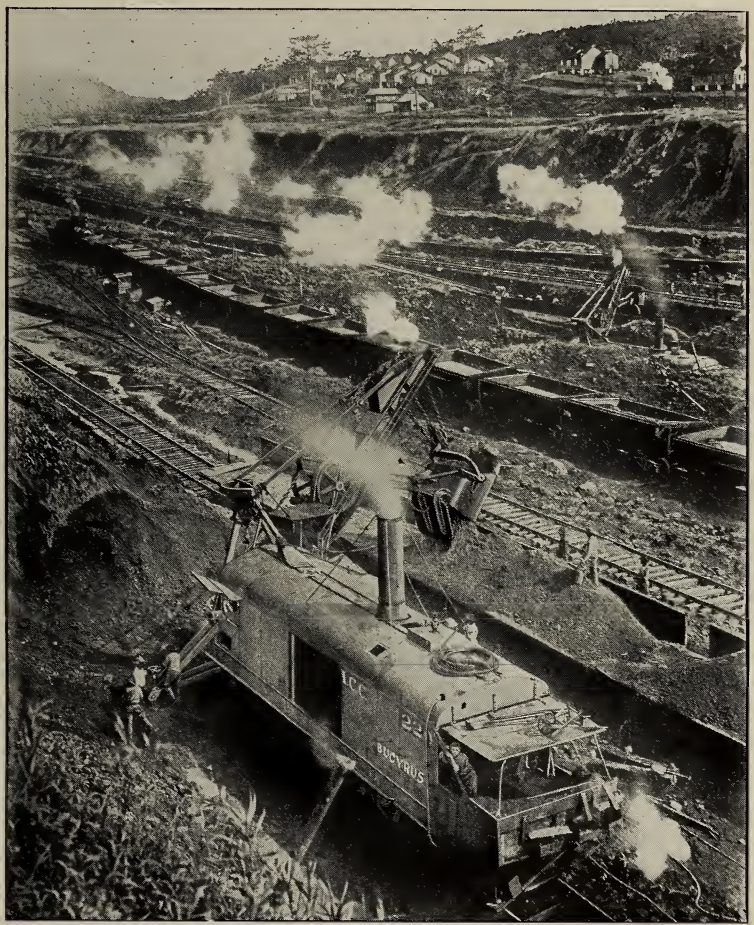
BUCYRUS SHOVELS At PANAMA



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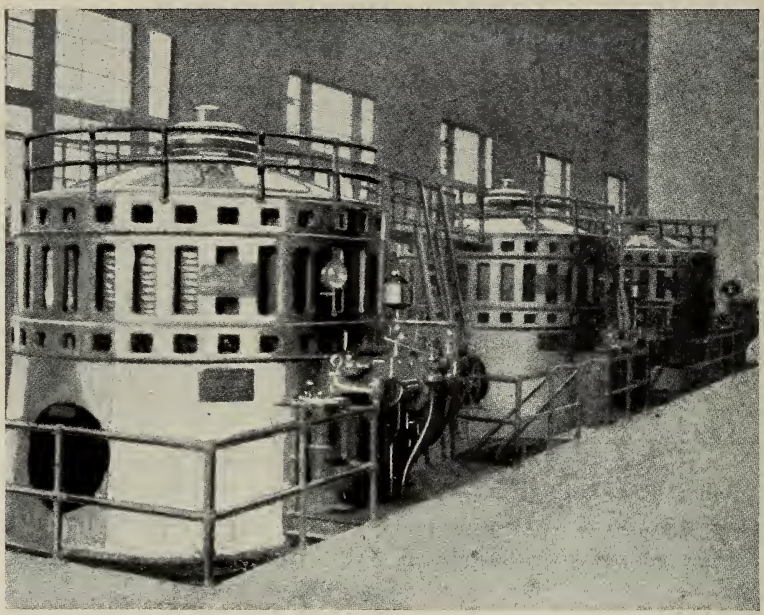

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Power for World's Greatest Engineering Feat Furnished by G-E Generators

All electric power used in building the Panama Canal is furnished by Curtis Steam Turbines.

All electric power for operating the permanent equipment of the Panama Canal, such as lock-gates, valves, emergency dams etc., will be supplied by water-wheel driven generators furnished by the General Electric Company.

The selection of this equipment based on rigid government specifications and in open competition shows merit—the merit necessary to insure dependable power.

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No Digging up of Street

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ROUND ROADWAY BOX

Cheaper and Better than Pits built up with Brick and Concrete

Quickly Installed

Withstands Heavy Traffic

Absolutely Protects The Valve

Like the square model, the Round Model Box is designed for the protection of large valves in the street. It meets the demand of those who prefer, or where local conditions require a circular construction.

The box is built up in sections, the complete circle being divided into several parts dovetailed together with grooves running the entire length of the section, therefore allowing for one section overlapping the other and making a break joint holding the box intact.

Sections are of three heights: 3-inch, 9-inch and 8-inch, to allow for adjustment of varying depths of trench. The whole box is supported by a base plate through which the valve stem extends. The top consists of a frame and cover for the frame resting on a series of cams or dogs of different heights so arranged as to allow for 3½ to 4-inch final grade adjustment. This same cover is also furnished with extended square corners for use where blocked pavements are used. This box is readily adaptable for culverts as well as roadway boxes. It is also used as a meter box.

S. E. T. Valve & Hydrant Co.

50 CHURCH STREET :: :: NEW YORK

An Engineer's Opinion

Why Wire-Cut-Lug Blocks Are Superior

William C. Perkins, M. Am. Soc. C. E., resident engineer Department of Highways, State of New York, Niagara Falls, N. Y., in a paper before Section D, American Society for the Advancement of Science, at their annual meeting, January 3, 1913, at Cleveland, Ohio, made the following reference to Wire-Cut-Lug Blocks:

"During 1912 the records show that nearly twenty-five million wire-cut-lug blocks were used in the highways of Western New York, although the specifications of the State Highway Department do not specify any style of block, merely requiring them to have lugs.

"What are the advantages of a wire-cut-lug block over a repressed block to the highway engineer?

"DENSITY: When a brick is repressed the molecular arrangement of the material is changed under pressure, and reforming may cause laminations. The fracture of a wire-cut block is smooth and even, showing great density; the fracture of a repressed block shows, very often, laminations and change of form and structure.

"BOND: The uniform lugs make a good alignment. The bricks are held an equal distance apart, allowing the free flow of filler or binding material; also, the rough, wire-cut surface, which comes in contact with the filler, gives a greater bonding strength than would the smooth surface of a repressed block.

"SURFACE: The edges of the block being square and sharp, the filler can be brought flush with the suface and will not break away under traffic, as it may from the rounded corners of repressed block.

"ALIGNMENT: Owing to the uniformity of the lug and the uniform size of the block, a good alignment can be obtained with very little effort, and it is therefore possible for a bricklayer to lay more square yards of pavement in a day.

"FILLER: Flush joints are more easily obtained. Two applications of cement grout are generally sufficient, thus a saving of labor.

"COST: The prices of wire-cut-lug blocks have not been increased over repressed."

The Dunn Wire-Cut-Lug Brick Company Of Conneaut, Ohio

(Licensor)

Patented in the United States and Foreign Countries

Save the Panama Canal

A Panama Canal could be built each year with the money the United States annually wastes on fires.

Real fire-proof construction would save much of this waste. The only real fire-proof building material is burned clay products, because clay products are subjected to excessive heat in manufacturing and are therefore fire tested.

There is always a good demand for burned clay products and the field is unlimited to an aggressive manufacturer.

We build machinery for making clay products of all classes. We install complete plants or re-habilitate old plants, making them profitable with modern equipment.

We underwrite success by testing the clay in advance, showing the finished product.

Where no clay is available and good sand is to be had, we install Sand-Lime-Brick machinery.

Correspondence solicited and catalogues sent on request.

The American Clay Machinery Company

Bucyrus, Ohio, U. S. A.

Monarch Pile Hammer

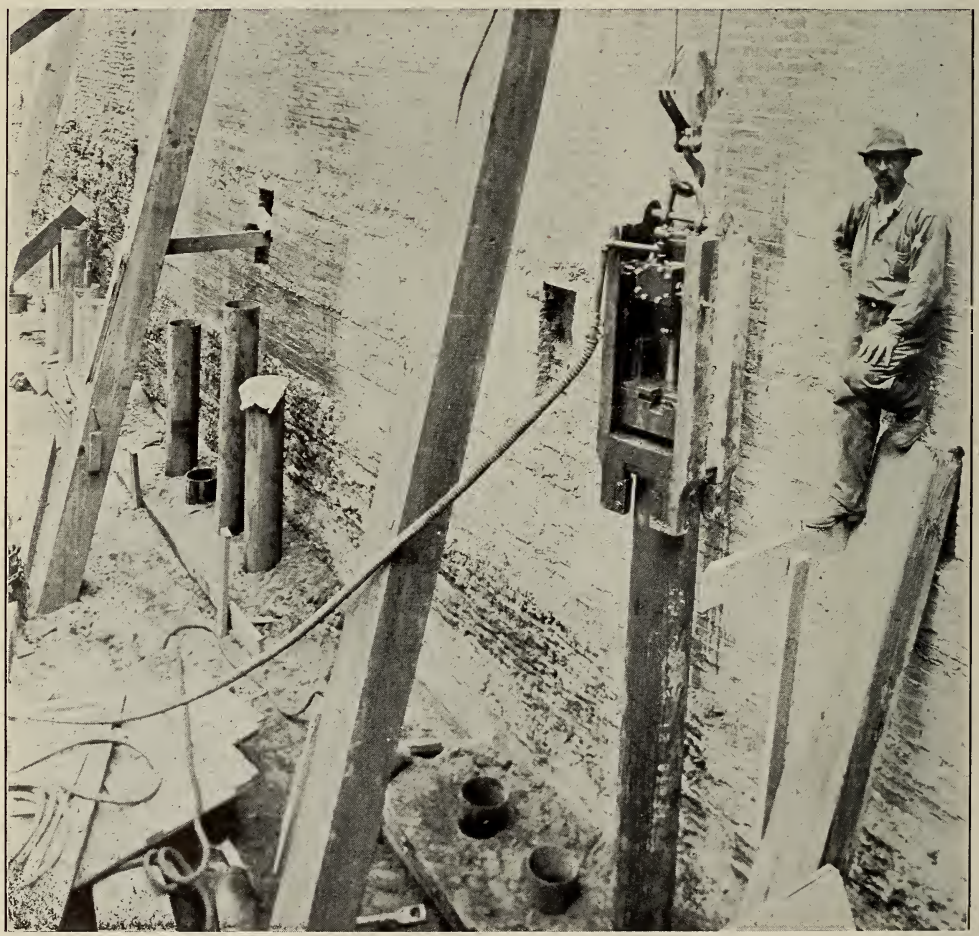
The fastest acting and most powerful Hammer in the world

Specially adapted for driving Steel Sheeting,
Wood Sheeting, Concrete and Wooden Piles

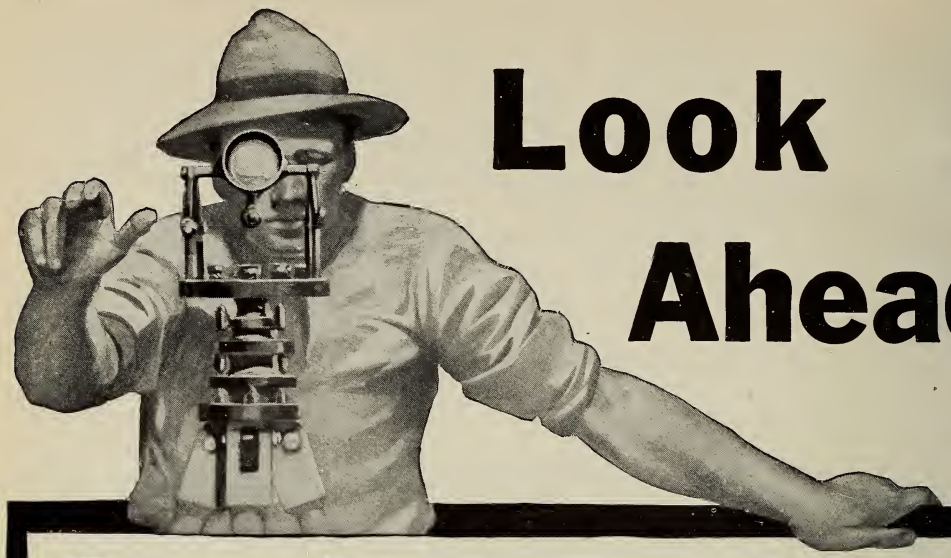
Made in sizes to suit all requirements

HENRY J. McCOY COMPANY

65 and 67 DEY STREET NEW YORK, N. Y.



The New Monarch Hammer driving steel pipe for Concrete Pile Foundation, 114 West 27th Street, New York



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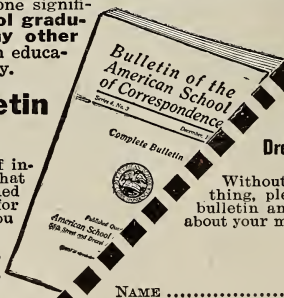

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6 Ransome concrete mixers.
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24-inch gauge cars and track.

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EQUAL TO NEW. GREAT BARGAIN
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1—60-Ton Marion Steam Shovel.

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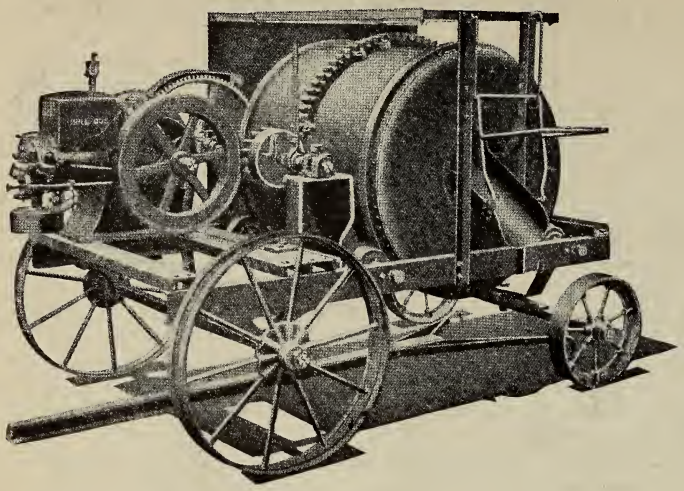

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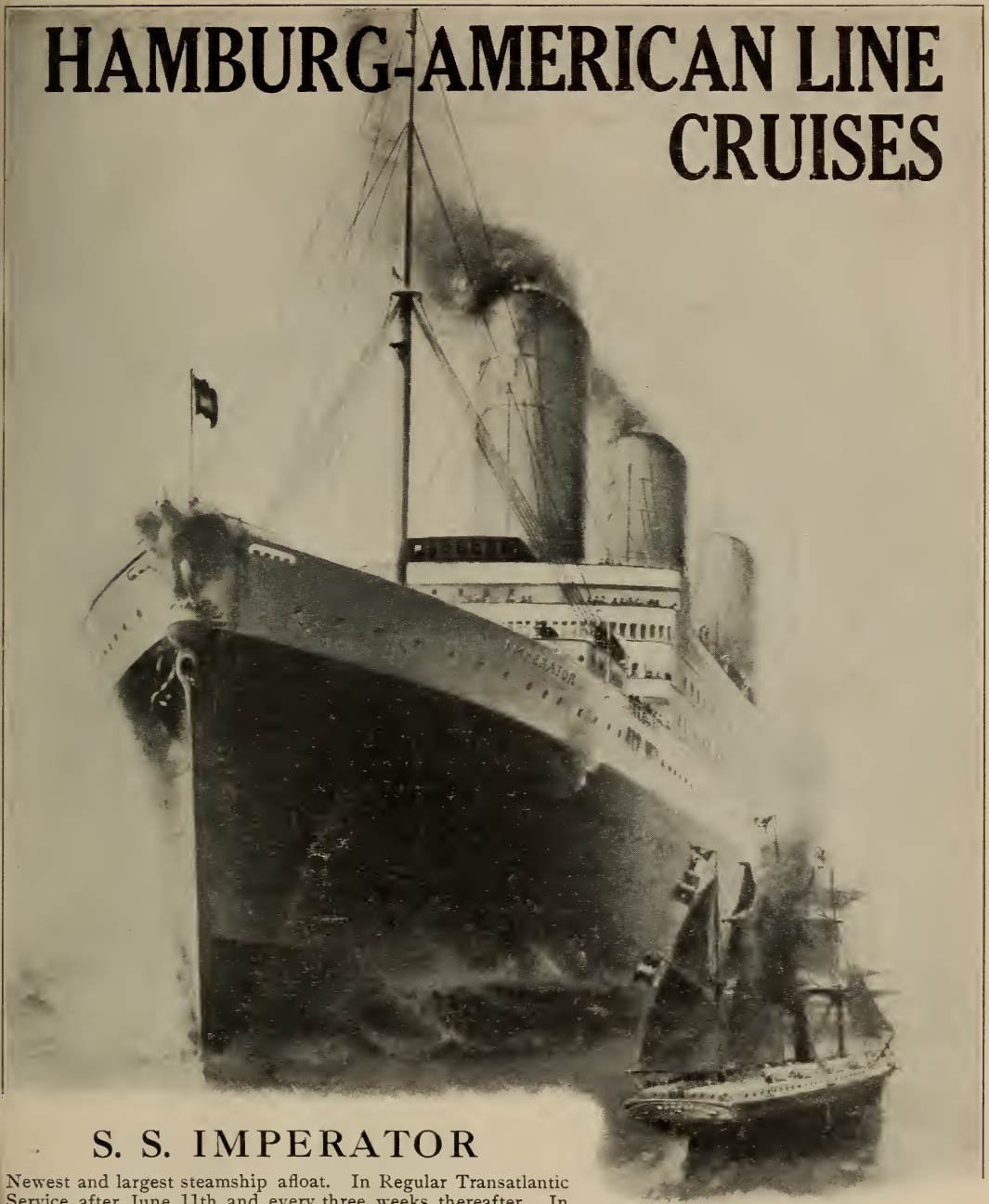

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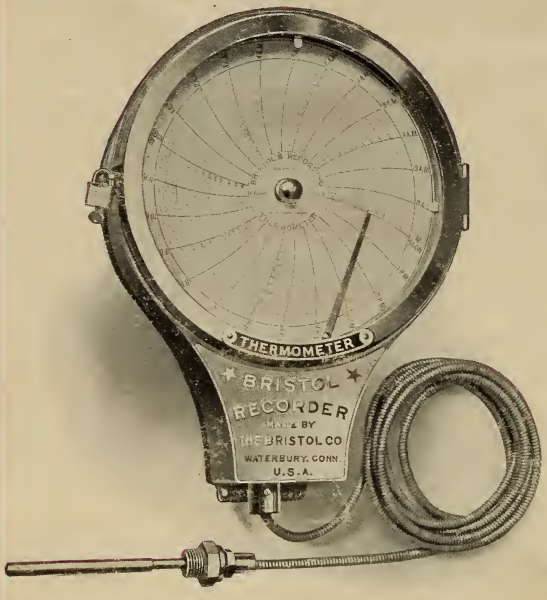

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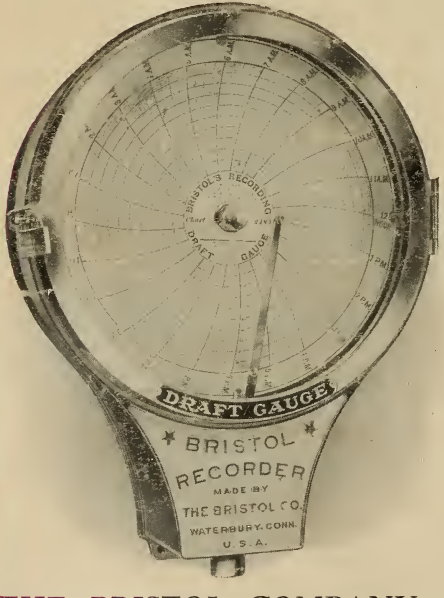

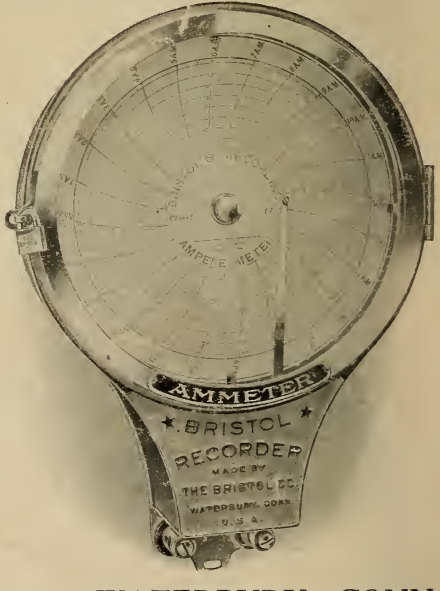

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